Commonwealth of Massachusetts

2000 Air Quality Report

Executive Office of Environmental Affairs
Department of Environmental Protection
Bureau of Waste Prevention
Division of Planning and Evaluation

Air Assessment Branch
Wall Experiment Station
37 Shattuck Street
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ACKNOWLEDGEMENTS

The data in this report represents the work of the Massachusetts Department of Environmental Protection (MADEP) Air Assessment Branch (AAB) to collect representative, complete, and accurate air quality data throughout the Commonwealth. This report includes results from the calendar year 2000.

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The photograph on the cover is the air monitoring site for acid deposition in Waltham.

This document is available in Adobe Acrobat PDF format from the MADEP web site. The address is mass.gov/dep/bwp/daqc.

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List of Abbreviations and Terms

AAB................Air Assessment Branch
AIRS...............Aerometric Information Retrieval System
AQI........... Air Quality Index
BP...................Barometric Pressure
CAA................Clean Air Act
CFR ....Code of Federal Regulations
CO ....Carbon Monoxide
CO_2 ....Carbon Dioxide
DVMT ....Daily Vehicle Miles Traveled
EOEA ....Executive Office of Environmental Affairs
MADEP..........Massachusetts Department of Environmental Protection
mg/m^3 ....milligrams per cubic meter
micron..........one-one millionth of an inch
NAAQS ....National Ambient Air Quality Standard
NADP ....National Atmospheric Deposition Program
NAMS ....National Air Monitoring Stations
NESCAUM ....Northeast States for Coordinated Air Use Management
NOAA ....National Oceanic and Atmospheric Administration
NO ....Nitrogen Oxide
NO_x ....Nitrogen Oxides
NO_y ....Total Reactive Oxidized Nitrogen
NO_2 ....Nitrogen Dioxide
NO_3 ....Nitrate
O_3 ....Ozone
PAMS ....Photochemical Assessment Monitoring Stations
Pb....................Lead
PEI..................Periodic Emissions Inventory
pH ....Concentration of hydrogen cations (H^+) in solution. An indicator of acidity.
ppb..................parts per billion by volume
ppm.................parts per million by volume
$PM_{2.5}$ ....Particulate matter 2.5 microns
PM_{10}................Particulate matter 10 microns
PSI ....Pollutant Standards Index
QA/QC...........Quality Assurance and Quality Control
RH ....Relative Humidity
SIP ....State Implementation Plan
SLAMS...........State and Local Air Monitoring Stations
SO_2..................Sulfur Dioxide
SO_4..................Sulfate
SUN............Solar Radiation
TSP ....Total Suspended Particulates
ug/m^3 ....micrograms per cubic meter
USEPA ....United States Environmental Protection Agency
VOC................Volatile Organic Compounds
WS/WD ....Wind Speed/Wind Direction

Executive Summary

Introduction

The Massachusetts Department of Environmental Protection (MADEP) monitors the outdoor air quality and requires emissions controls, as necessary, for pollutants that adversely affect the public health and welfare. This report summarizes the results of this monitoring effort in 2000 and identifies long-term trends of air quality and emissions data.

Criteria pollutant monitoring

During 2000, MADEP analyzed the ambient air for ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter 10 microns and smaller (PM_{10}), particulate matter 2.5 microns and smaller ($PM_{2.5}$) and lead (Pb). These are criteria pollutants, which the U.S. Environmental Protection Agency (USEPA) requires states to monitor.

Enhanced ozone monitoring

Enhanced ozone monitoring continued during 2000 and included the measurement of volatile organic compounds (VOCs). VOCs are contributors to the formation of ozone. This is also called the Photochemical Assessment Monitoring Station program (PAMS). PAMS monitoring can also yield information regarding concentrations of pollutants known or suspected to cause cancer or other serious health effects, such as birth defects.

$PM_{2.5}$ and Speciation

During 2000, monitoring for $PM_{2.5}$ occurred at 21 sites located in 16 cities throughout Massachusetts. $PM_{2.5}$ comprises very fine particulates (2.5 microns and smaller). Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence. USEPA added $PM_{2.5}$ as a particulate standard, in addition to the PM_{10} standard, following studies that indicate smaller particles are largely responsible for adverse health effects.

MADEP has begun to expand its measurement of $PM_{2.5}$ related particles to include continuous PM, black carbon and $PM_{2.5}$ speciation. Speciation, which uses chemical analysis to identify specific components of particulate matter, provides data for source characterization and health effects studies.

How are the data used?

The outdoor monitoring data are used to:

- determine whether Massachusetts is meeting public health standards for air;
- report the state of air quality in the Commonwealth; and
- assess impacts of air pollution control strategies in reducing risks to public health and the environment.

Factors affecting air quality trends

Air quality is influenced by many factors. Over the past 25 years, Massachusetts and neighboring states have initiated many control measures to reduce the level of man-made pollutants emitted into the air. These measures include factory emission regulations, new automotive and fuel standards, and incentives to reduce pollution such as car pool lanes. These have resulted in significant air quality improvements.

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Factors affecting air quality trends Continued

Peak O_3 levels in Massachusetts, for example, have dropped significantly since the 1980s, with peak values today measuring some 30% lower than those in the 1980s. Despite this improvement, O_3 levels averaged over 8 hours remain high. Also, because of meteorological fluctuations, there exist striking year-to-year variations in the frequency of elevated O_3 and, thus, the population's exposure to O_3.

While the state of the economy, as reflected by industrial and commercial activity and the resultant levels of emissions, contributes to these fluctuations, the role of meteorology is significant. On a given day, meteorology governs how much ozone-related pollution enters the state from other areas, and whether sunshine is present to drive the chemical reactions that produce O_3. Over a season, the frequency of ozone-favorable weather, and thus the severity of the O_3 season, is related to the position and strength of the upper air jet stream. Therefore, as jet stream behavior changes year-to-year, so does O_3 season severity.

Ozone exceedance trends

There are two air quality standards in 2000 for Ozone (O_3): one for values averaged over a 1-hour period and a newer, more stringent standard averaged over an 8-hour period. The 8-hour standard was instituted in 1997 in response to studies that indicate that longer-term exposures to lower O_3 levels cause adverse health effects.

On five days during 2000, unhealthy (exceedance) 8-hour O_3 levels were found somewhere in the state, many fewer than 1999's total of 22 exceedance days. There were a total of 15 exceedances of the 8-hour standard in 2000 (85 in 1999) which took place during those five days. During 2000, for the 1-hour standard, there was one exceedance day and a total of one exceedance.

Trends of 1-hr and 8-hr O_3 exceedances are shown in Figures 1 and 2 respectively. The trend for 1-hour exceedances shows great reduction in the number of occurrences. The trend for the 8-hour exceedances has some peaks with a gradual decrease in the number of events.

8-hr O3 Exceedance Days & Total Exceedances 1987-2000 Ozone exceeded the 8-hour standard (0.085 ppm)

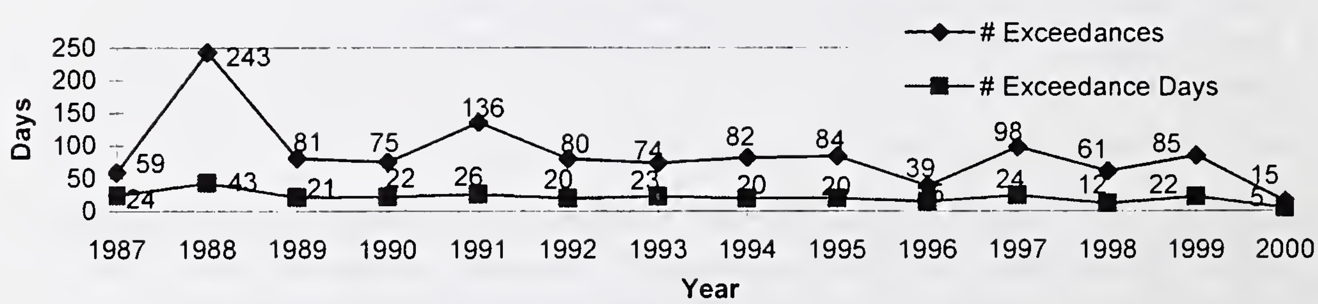

Figure 1

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Ozone exceedance trends Continued

The long-term O_3 exceedance trends show that, under the more stringent 8-hour standard, there are more exceedances compared to the 1-hour federal standard.

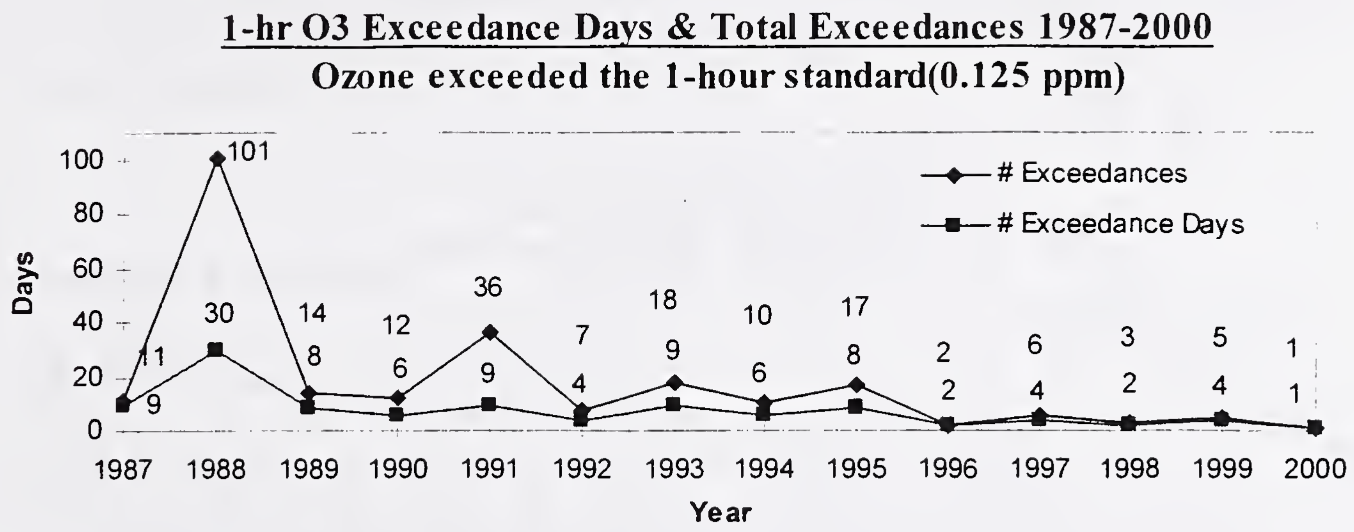

Figure 2

Carbon monoxide trend

The carbon monoxide (CO) 8-hour values show a long-term trend downward for the period. CO, as indicated below by the 8-hour 2nd-maximum concentration, has decreased by 54% over the period. Massachusetts is well below the federal standard.

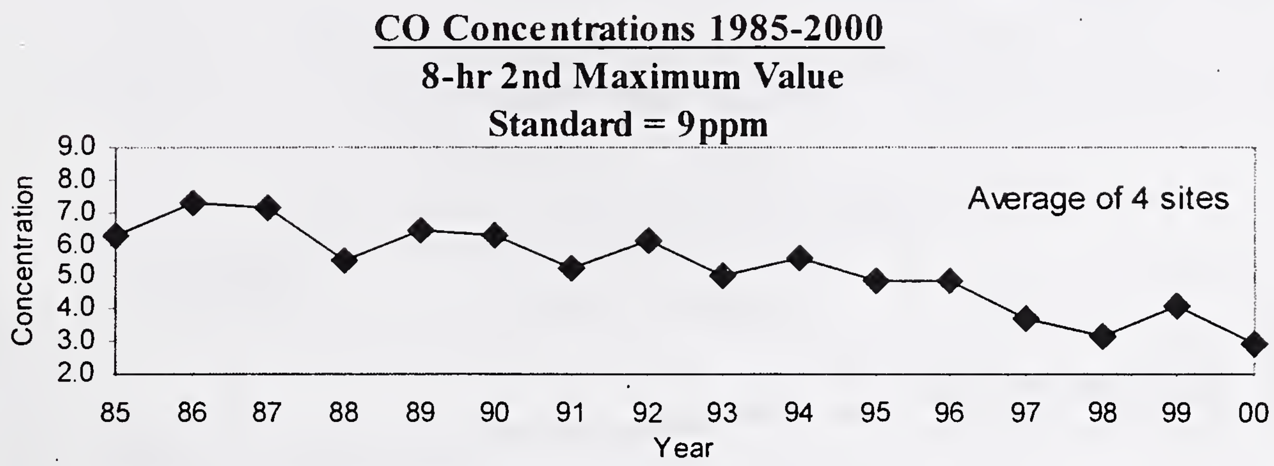

Figure 3

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NO2 Concentrations 1986-2000
Annual Arithmetic Mean
NO2 standard = .053 ppm

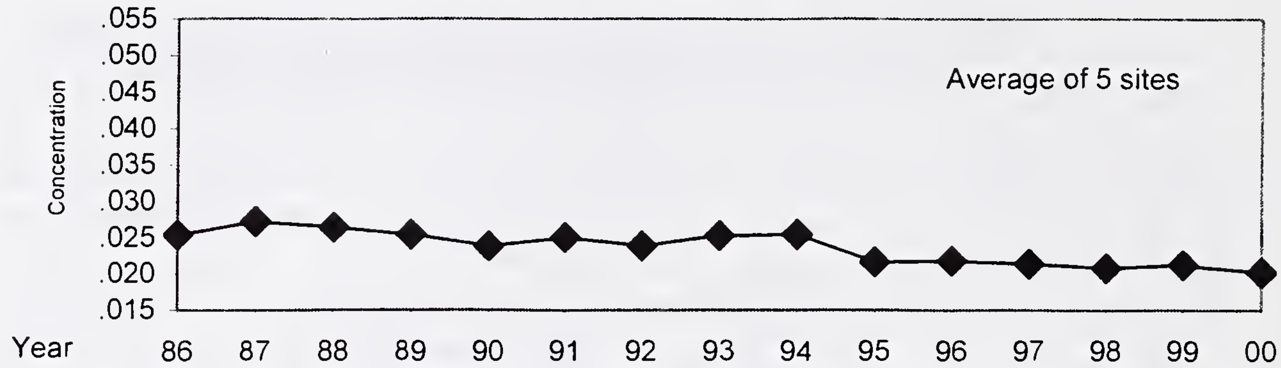

Figure 4

Nitrogen dioxide trend

The nitrogen dioxide (NO_2) long-term trend, shown above, has been stable the last few years. However, over the 15 year period, the annual arithmetic mean concentration has decreased by 30%. Massachusetts is well below the federal standard.

Sulfur dioxide trend

The sulfur dioxide (SO_2) long-term trend, shown below, has been stable the last few years. Over the period, the annual arithmetic mean concentration has decreased by 55%. Massachusetts is below the federal standard.

SO2 Concentrations 1986 - 2000
Annual Arithmetic Mean
Standard = 0.03 ppm

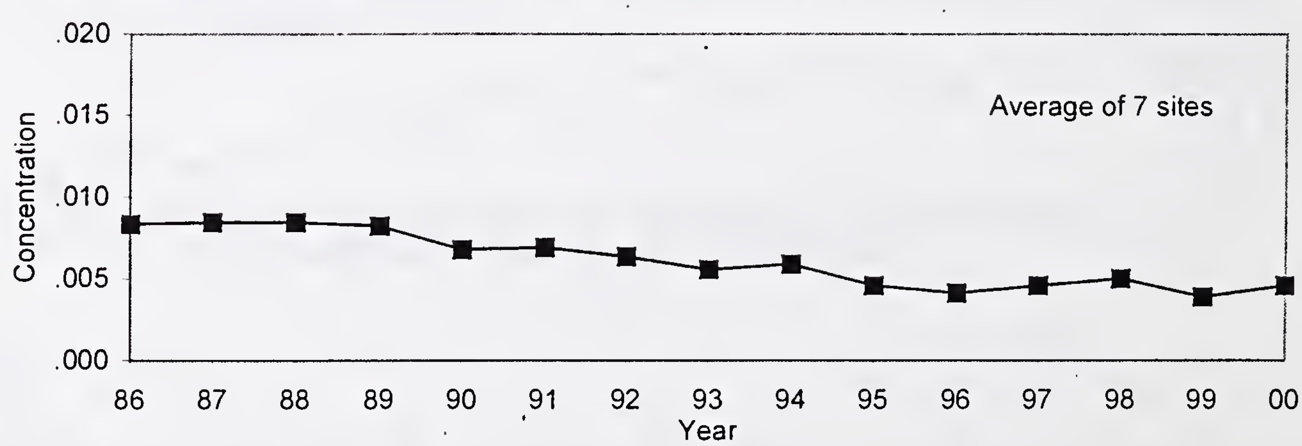

Figure 5

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Particulate matter (PM_{10}) trend

The long-term trend of particulate matter levels 10 microns and smaller (PM_{10}) has been stable the last few years. For the period, the annual arithmetic mean concentration has decreased by 14%. Massachusetts is below the federal standard.

Monitoring for particulate matter 2.5 microns and smaller ($PM_{2.5}$) began in 1999, so there is insufficient data for trend analysis or compliance determination. Designation for the $PM_{2.5}$ standard requires three years of data.

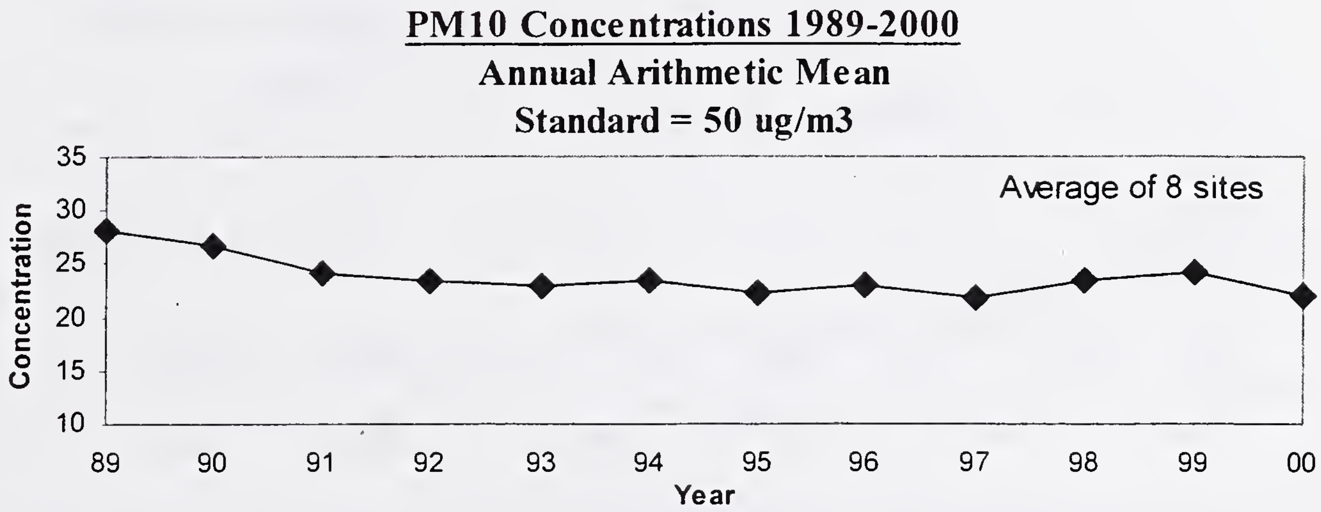

Figure 6

Lead trend

In 1998, the USEPA required that lead (Pb) monitoring be reinstituted at one site in Boston. This monitoring had been discontinued in June 1995. As Figure 7 indicates, the concentration of Pb in the air decreased substantially since the 1980s. This result is attributed to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions. Massachusetts is well below the federal standard.

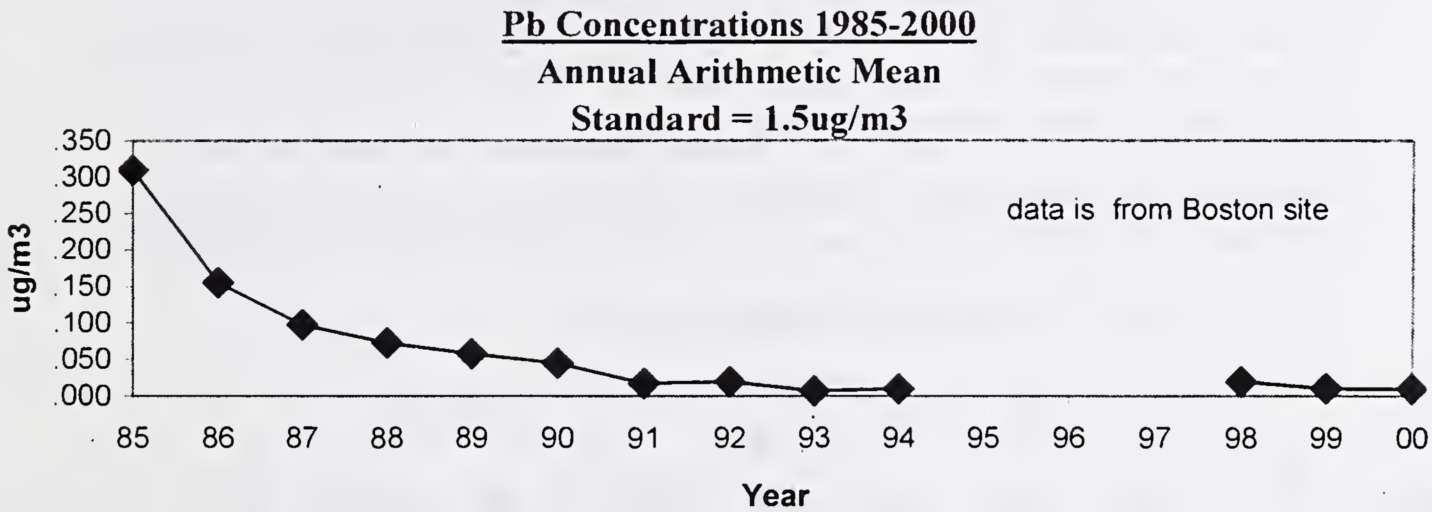

Figure 7

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PAMS monitoring

PAMS monitoring for VOCs has been conducted for six years. Analyses of the concentration levels indicate a decline in certain toxic VOCs. There have been substantial decreases in benzene. The decrease is probably the result of the use of reformulated gas beginning in 1995, which has reduced the emissions of these toxic pollutants significantly. Benzene has known human health effects and has been assigned a very low AAL. Benzene is ubiquitous in the ambient air along with other volatile petroleum hydrocarbons. The trend for benzene for the Lynn and Chicopee sites is shown in Figure 8.

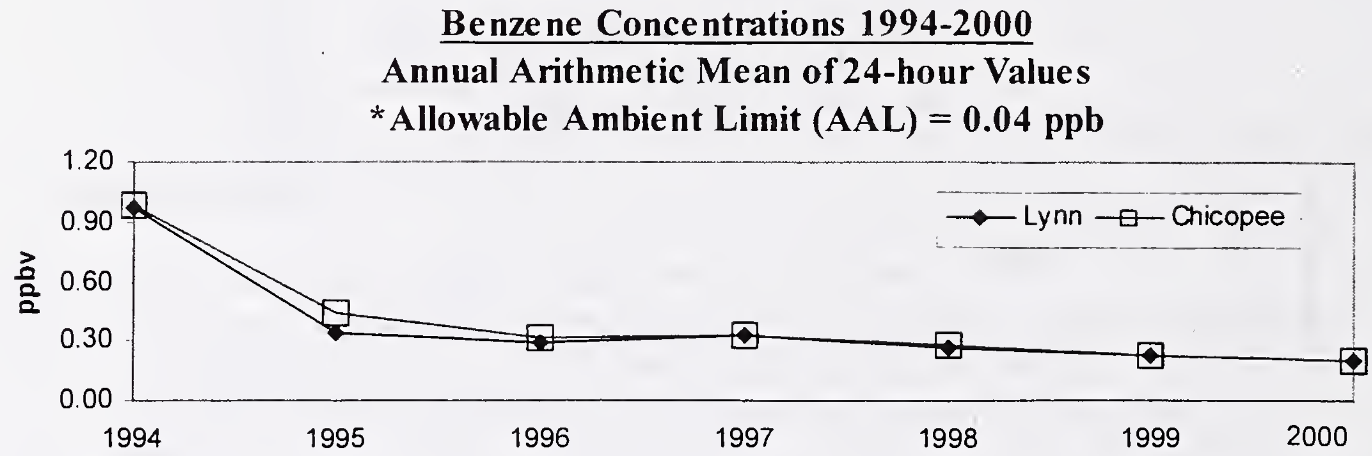

Figure 8

*Allowable Ambient Limits (AALs) are health-based air toxics guidelines developed by MADEP based on potential known or suspected carcinogenic and toxic health properties of individual compounds. Safety factors are incorporated into the AALs to account for exposures from pathways other than air. AALs are reviewed and updated periodically to reflect current toxicity information.

Point source emission trends

Point sources are large manufacturing facilities and power plants. Emissions inventories must be reported to the USEPA as part of the State Implementation Plan (SIP) because, in 2000, Massachusetts was non-attainment for the O_3 and CO national air quality standards. The O_3 SIP describes the estimated emissions and control measures for O_3 precursors including VOCs and nitrogen oxides. The 1990 SIP included a base year emissions inventory for VOCs, NO_x, and CO, from which air pollution programs were developed.

Figure 9 indicates substantial decreases in VOCs during the period 1990-1999 and an increase in CO point source emissions.

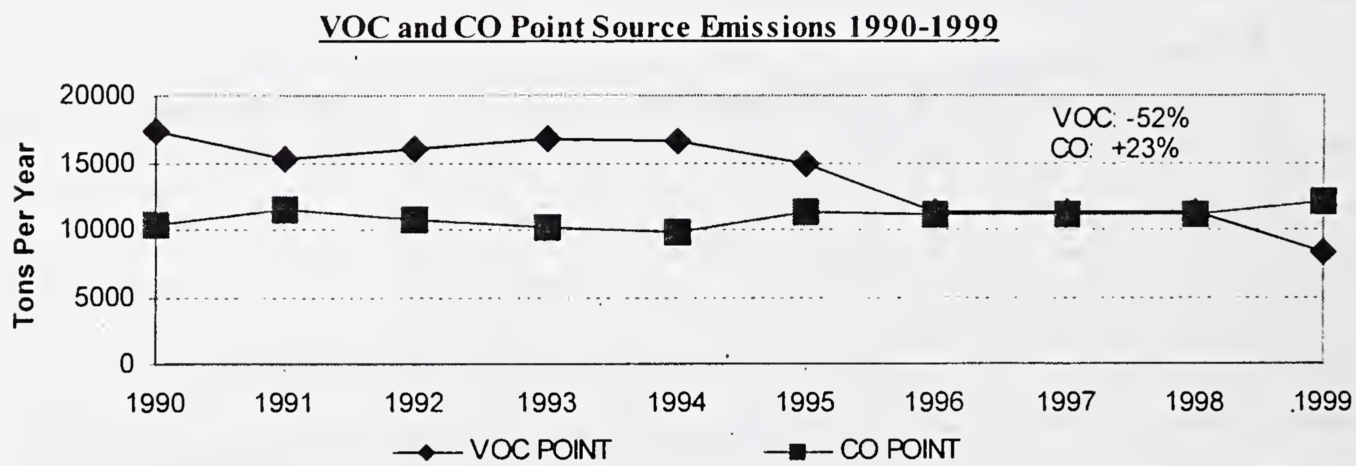

Figure 9

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Point source emission trends Continued

SO_2 emissions are tracked annually by MADEP as required by the 1985 State Acid Rain (STAR) program. The STAR program was implemented to control emissions that cause acid deposition, which is harmful to the environment. NO_x emissions contribute to both acid rain and ozone formation.

Figure 10 shows there have been substantial decreases in SO_2 and NO_x emissions from point sources during the period 1990-1999. Year-to-year changes in emissions reflect the adoption of new controls as well as weather and economic conditions.

Emissions of SO2 and NOx from Point Sources 1990-1999

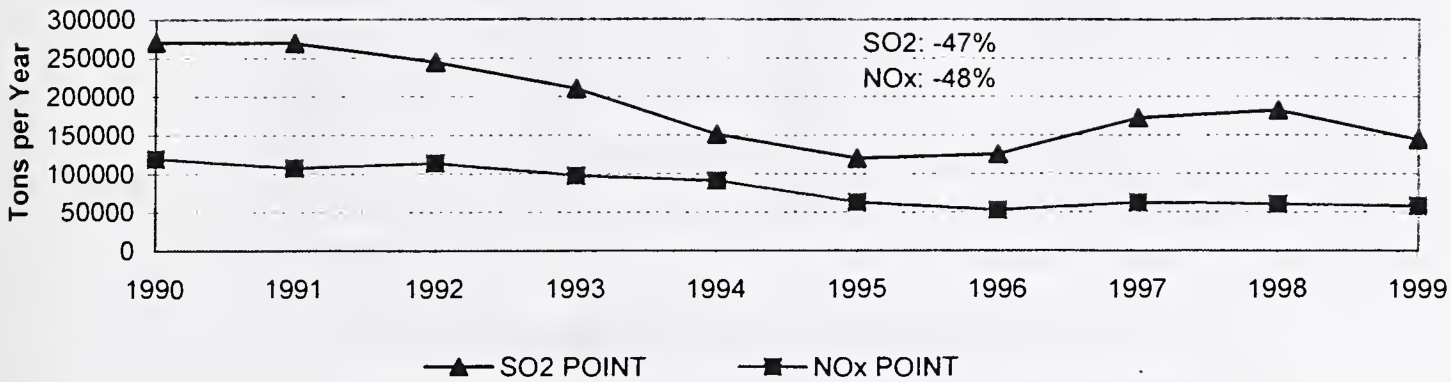

Figure 10

On-road mobile source emission trends

On-road mobile sources include vehicles such as autos, trucks, motorcycles, and buses. Figure 11 shows the 1990-1999 trends for on-road mobile VOC, NO_x, and CO emissions, together with daily vehicle miles traveled (DVMT).

The VOC on-road mobile emissions decreased by 34% despite an increase of 15% in DVMT. This is a reflection of the effective on-road mobile source control programs that were instituted during this period, such as controls on car tailpipe emissions, use of reformulated gasoline, and fuel controls such as Stage II vapor recovery systems at gasoline stations.

NO_x on-road mobile emissions increased by 8% during the 1990-1999 period. NO_x controls for new vehicles were put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

CO is by far the major pollutant from on-road mobile sources. The CO emissions reflected in Figure 11 are one-third of the actual value in order to make the other pollutant values visible on the graph.

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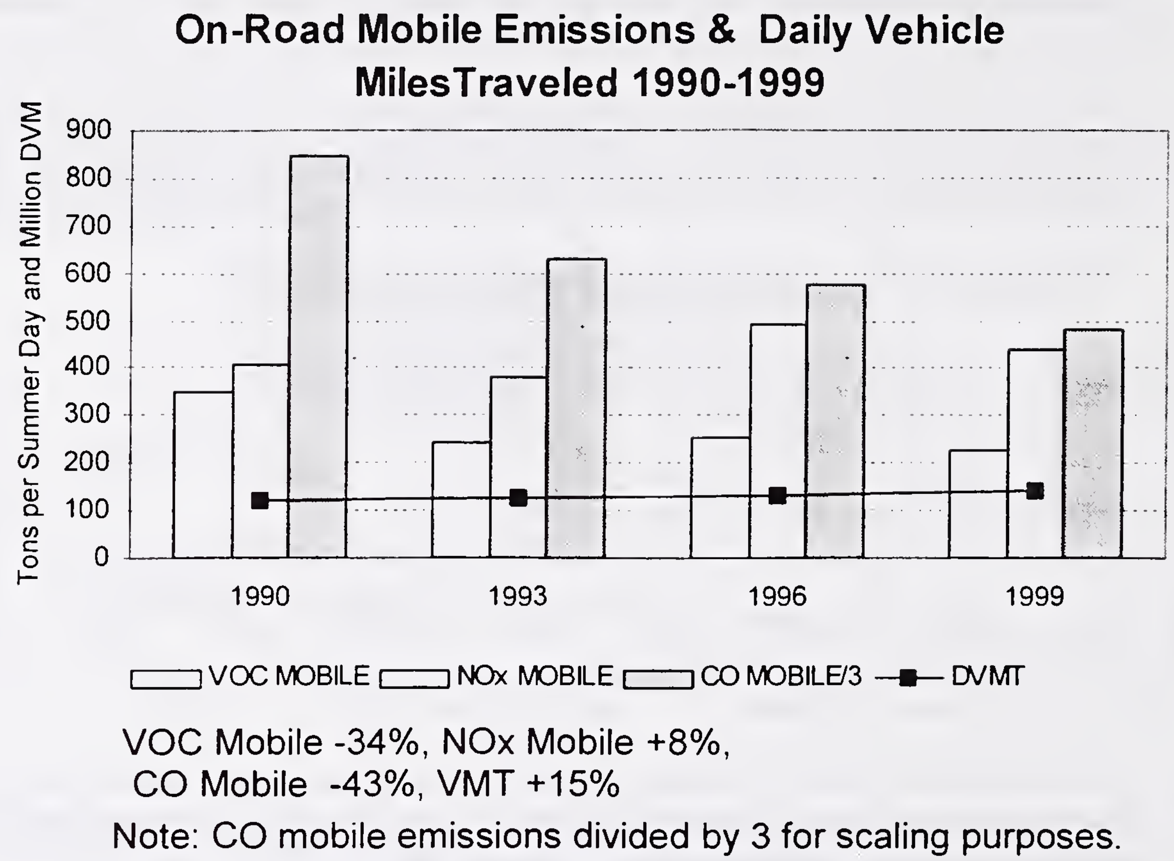

Figure 11

The emission trends presented in Figures 9, 10, and 11 are based on the 1999 Periodic Emissions Inventory (PEI). The PEI is done every 3 years.

The continuing need for emission controls

While current data trends are downward for many pollutants, existing emission control programs need to be maintained and improved to sustain the improvements to date and offset expected from increased economic activity and population.

Developments related to 8-hour ozone standards

In 1997, the USEPA adopted a new 8-hr ozone standard, which became the subject of litigation. As part of the designation process for the new standard, then-Governor Cellucci submitted a letter to the USEPA in July 2000. Based on 8-hr ozone data for the three-year period 1997-1999, he recommended that Eastern and Western Massachusetts be designated "non-attainment" under the new standard.

Litigation related to the new standards continues and the USEPA has not made formal designations of attainment areas. In February 2001, the U.S. Supreme Court upheld the new standards but remanded the case back to the D.C. Circuit Court for reconsideration of a number of legal issues. There is no timetable for implementation of the new standards in light on the ongoing legal action.

Section I

Ambient Air Monitoring Program

Program Overview

Introduction

Regulations set forth in the Code of Federal Regulations (Title 40, Part 58) require each state to establish an air monitoring network. A network of National Air Monitoring Stations (NAMS) located in urban areas and based on population provides a consistent nationwide database. The State and Local Air Monitoring Stations (SLAMS) network includes NAMS plus additional sites. This provides a comprehensive assessment of air quality.

The Air Assessment Branch (AAB) of the Department of Environmental Protection (MADEP) collects ambient air quality data from sites throughout Massachusetts. During 2000, AAB operated a monitoring network of 40 stations publicly funded located in 25 cities and towns. AAB also oversaw a separate industrial network of six stations located at industries in 3 municipalities.

MADEP submits ambient air quality data to the Aerometric Information Retrieval System (AIRS), a computer-based repository of national air quality information administered by the U.S. Environmental Protection Agency (USEPA).

Why is air quality data collected?

The ambient air quality data is used for the following purposes:
- to verify compliance with national ambient air quality standards;
- to support development of policies and regulations designed to reduce ambient air pollution;
- to assess the effectiveness of existing air pollution control strategies;
- to provide aerometric data for long-term trend analysis and special research; and
- to fulfill USEPA reporting requirements for ambient air quality data.

What is monitored?

The parameters monitored by the Air Assessment Branch fall into the following categories:

- **Criteria pollutants** are subject to National Ambient Air Quality Standards (NAAQS). The seven criteria pollutants are:
  - sulfur dioxide (SO_2)
  - ozone (O_3)
  - carbon monoxide (CO)
  - nitrogen dioxide (NO_2)
  - lead (Pb)
  - particulate matter 10 microns (PM_{10})
  - particulate matter 2.5 microns ($PM_{2.5}$)

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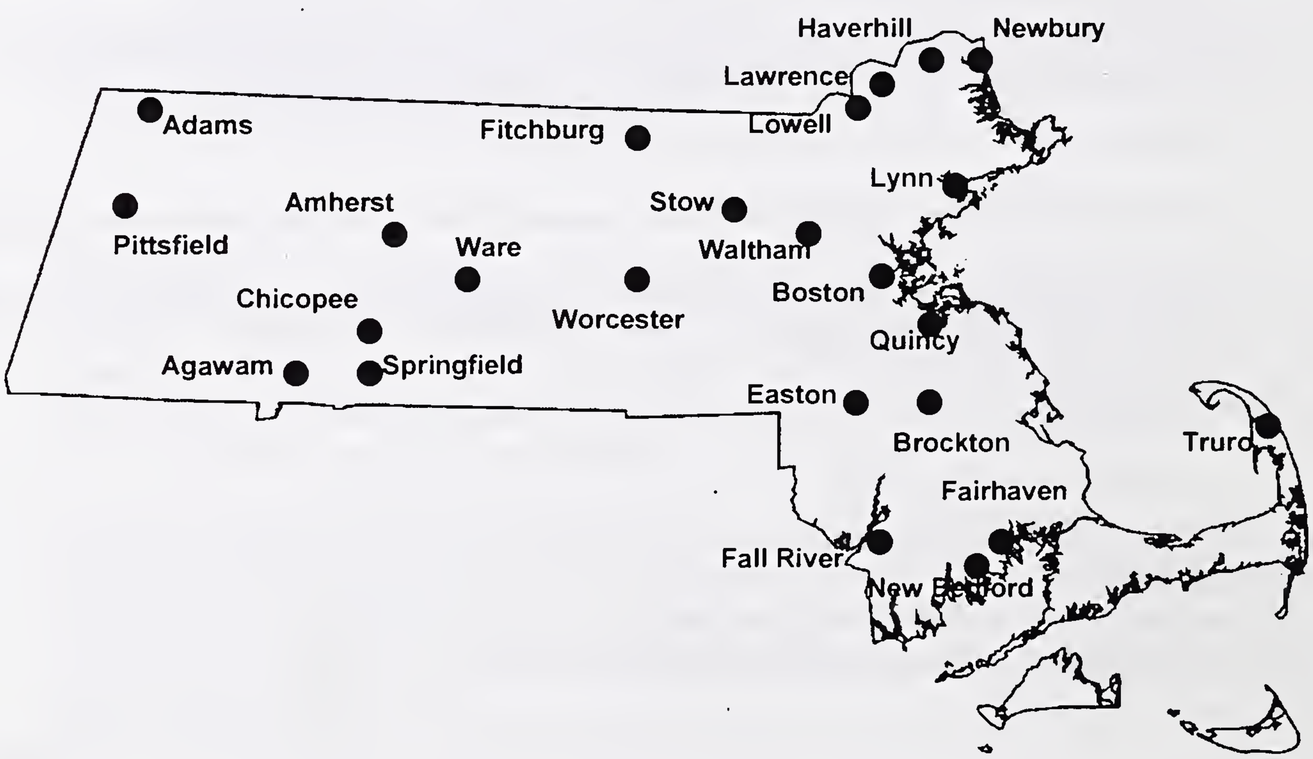
What is monitored? Continued

- **Non-criteria pollutants** have no established national standards. These pollutants are:
  - nitrogen oxide (NO)
  - total nitrogen oxides (NO_x)
  - total reactive oxidized nitrogen (NO_y)
  - total suspended particulates (TSP)
  - volatile organic compounds (VOC) – ozone precursors and reaction product chemicals measured as part of the Photochemical Assessment Monitoring Stations (PAMS) program
  - black carbon
- **Meteorological parameters** monitored are:
  - wind speed/wind direction (WS/WD)
  - relative humidity (RH)
  - temperature (TEMP)
  - barometric pressure (BP)
  - solar radiation
  - Upper air wind and Temperature

Monitoring station locations

The monitoring locations for the different pollutants are sited to provide data for various purposes. Some sites are located in "hot spots" where maximum concentrations are expected, while others provide data which is representative of larger land areas. The topography and the location of pollutant sources are factors that determine the scale of representation for a particular monitor location.

Each pollutant has a network of monitors located throughout the state. These networks are designed to reflect pollutant concentrations accurately for all of Massachusetts. Section III contains data summaries for each pollutant and maps showing the monitor locations for each network. Also, the site directory in this section lists the different monitors located at each site. The map below shows Massachusetts cities and towns that had monitors during 2000.



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For further information

For further information pertaining to this report, contact the Air Assessment Branch. For information about other air quality matters, please contact MADEP's Division of Planning and Evaluation in Boston, or a MADEP regional office. The addresses are listed below. Maps showing the cities and towns covered by each regional office are on the following pages.

MADEP – WERO (WESTERN) 436 Dwight Street Springfield, MA 01103 (413) 784-1100 Michael Gorski: Regional Director	**MADEP - CERO (CENTRAL)** 627 Main Street Worcester, MA 01608 (508) 792-7650 Robert W. Golledge Jr.: Regional Director
MADEP - NERO (NORTHEAST/MET-BOSTON) 205A Lowell Street Wilmington, MA 01887 (978) 661-7600 William Gaughan: Regional Director	**MADEP - SERO (SOUTHEAST)** 20 Riverside Drive Lakeville, MA 02347 (508) 946-2700 Paul Taurasi: Regional Director
BUREAU OF WASTE PREVENTION **Division of Planning and Evaluation** One Winter Street Boston, MA 02108 (617) 292-5500 James C. Colman: Assistant Commissioner	**AIR ASSESSMENT BRANCH** William X. Wall Experiment Station Lawrence, MA 01843 (978) 975-1138 Jerry Sheehan: Branch Chief

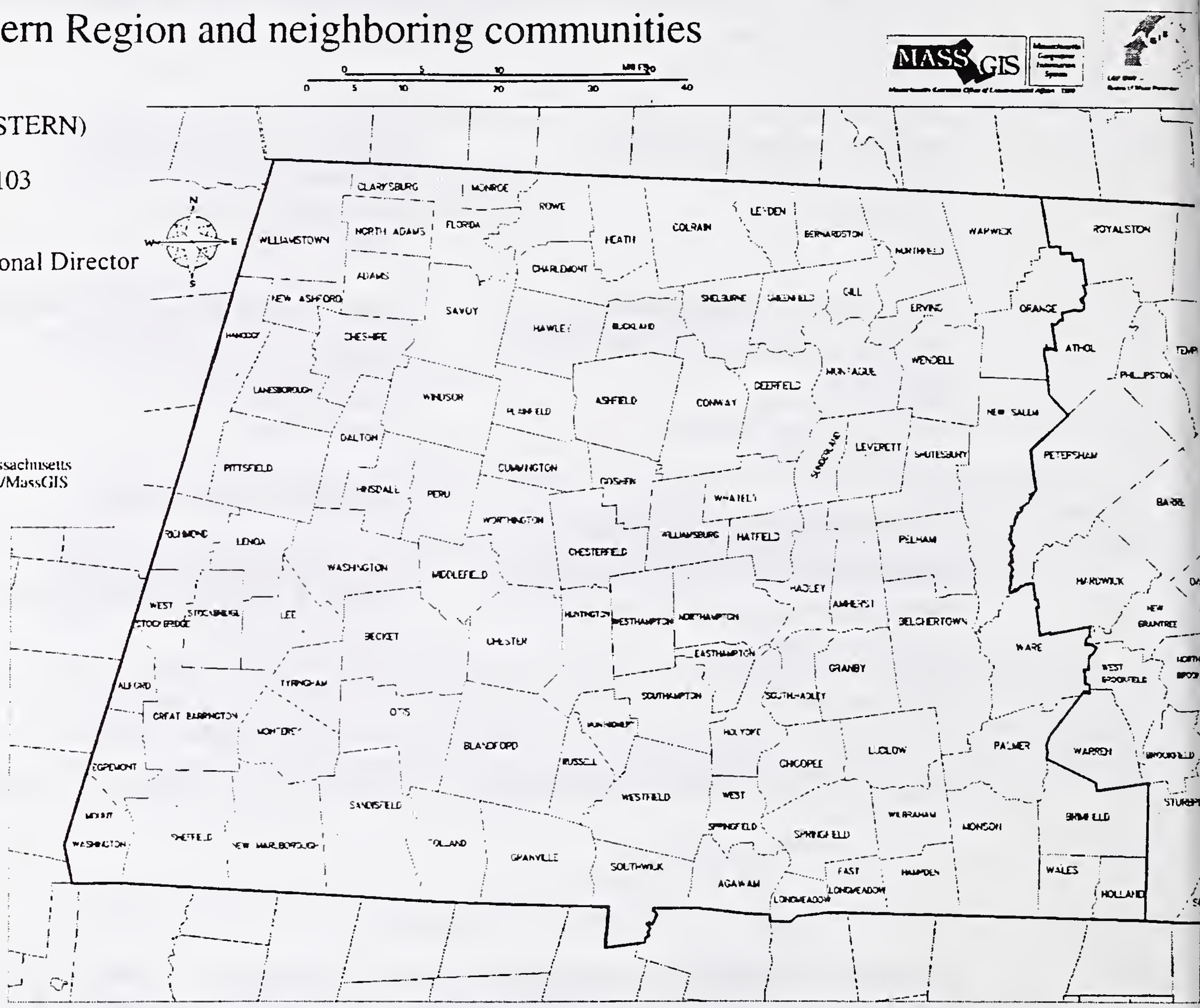
Information about MADEP's various programs and this report are available on the internet from MADEP's web site (mass.gov/dep/). The USEPA maintains a web site (www.epa.gov/air/data/), which has air quality information from all the states.

MADEP's Western Region Map

DEP's Western Region and neighboring communities

DEP -WERO (WESTERN)
436 Dwight St.
Springfield, MA 01103
(413)784-1100

Michael Gorski: Regional Director



DATA SOURCES:

Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS

/dep/projects/daqc1/monmaps/at-regions.aml

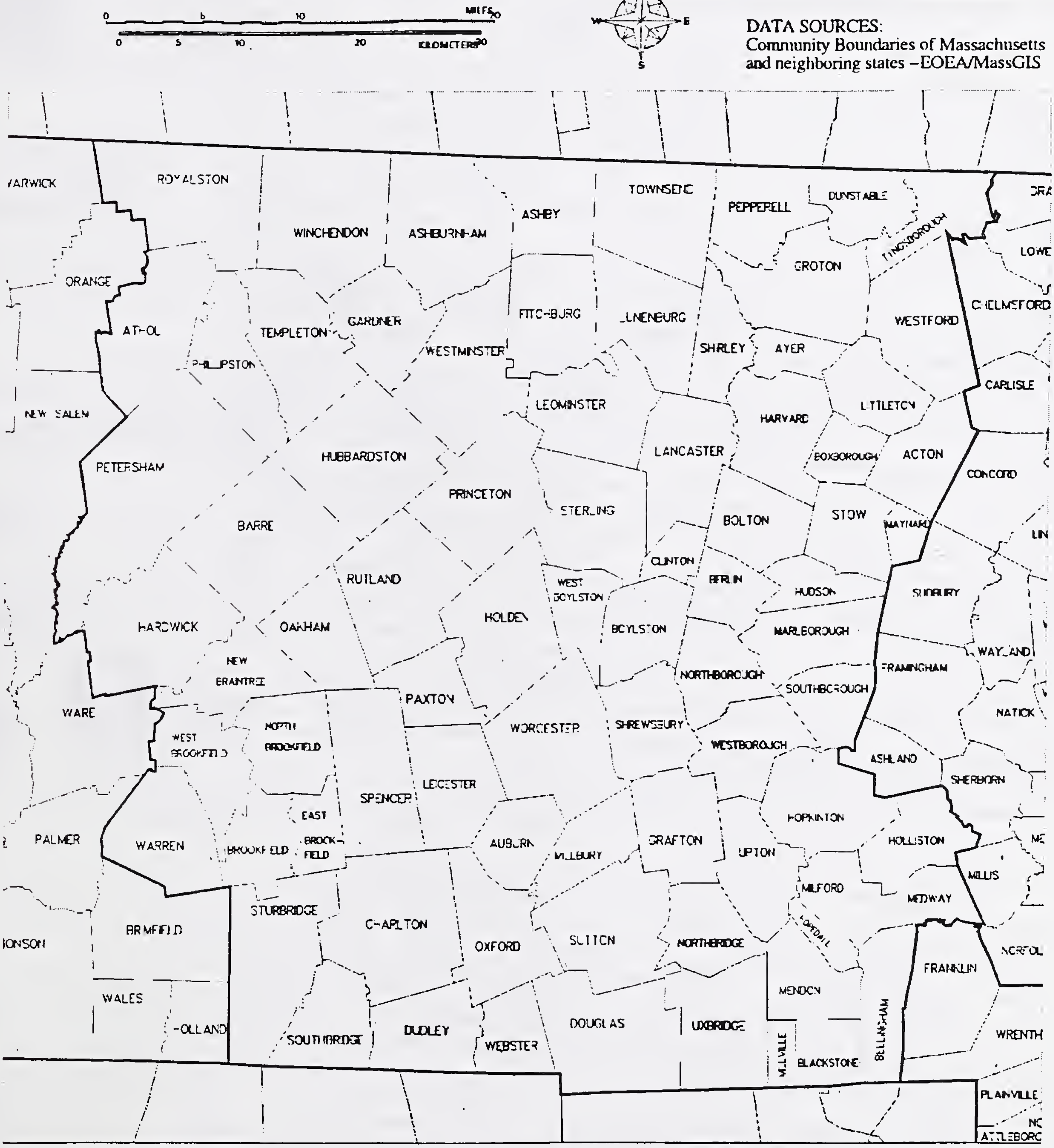
MADEP's Central Region Map

DEP's Central Region and neighboring communities

DEP –CERO (CENTRAL)
627 Main St.
Worcester, MA 01608
(508)792–7650

Robert Golledge: Regional Director

DATA SOURCES:
Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS



/dep/projects/daqc1/mommaps/at-regions.aml

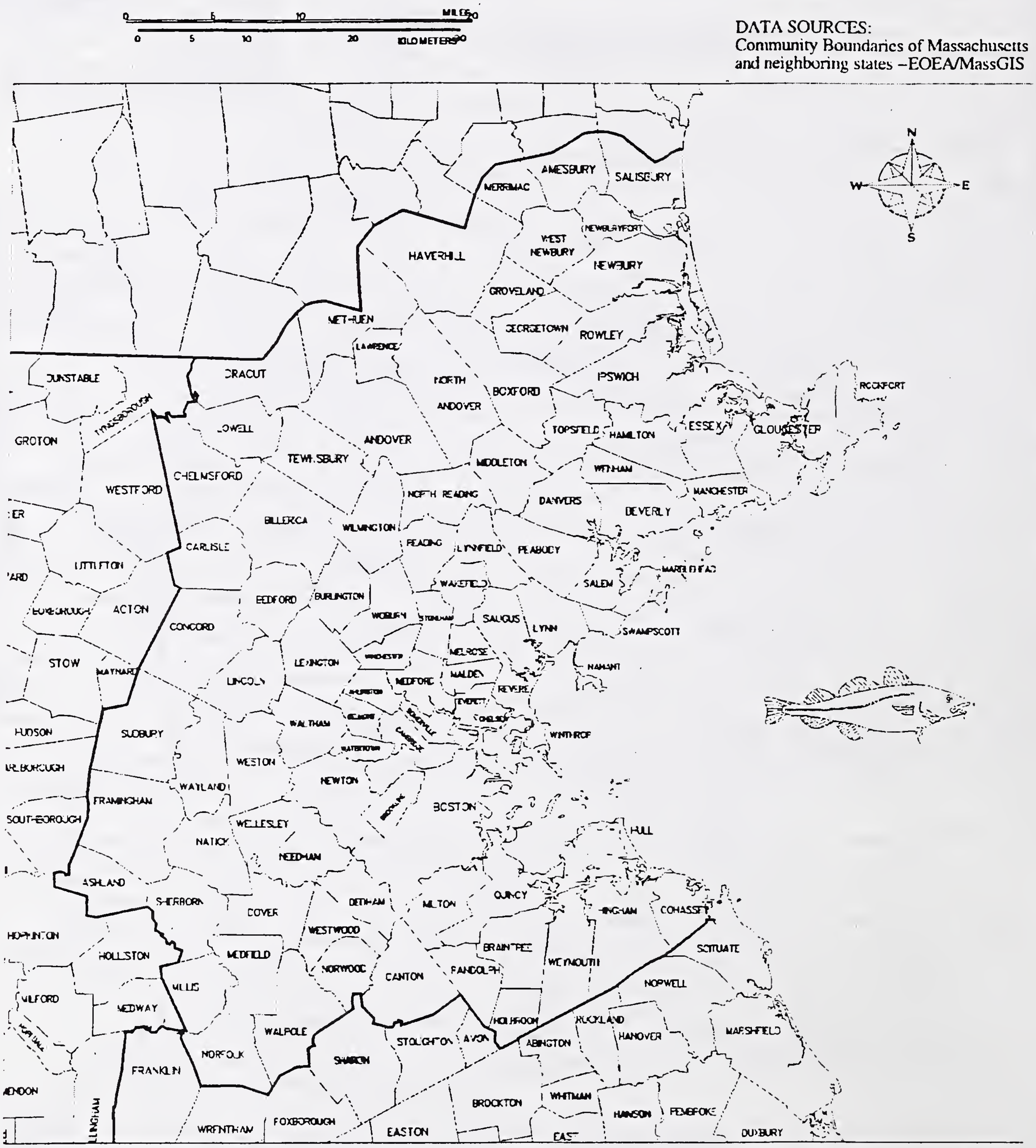
MADEP's Northeast Region Map

DEP's Northeast Region and neighboring communities

DEP –NERO (NORTHEAST/MET-BOSTON)
205A Lowell St.
Wilmington, MA 01887
(978)661-7600

William Gaughan: Regional Director

DATA SOURCES:
Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS



/dep/projects/daqc1/monmaps/at-regions.aml

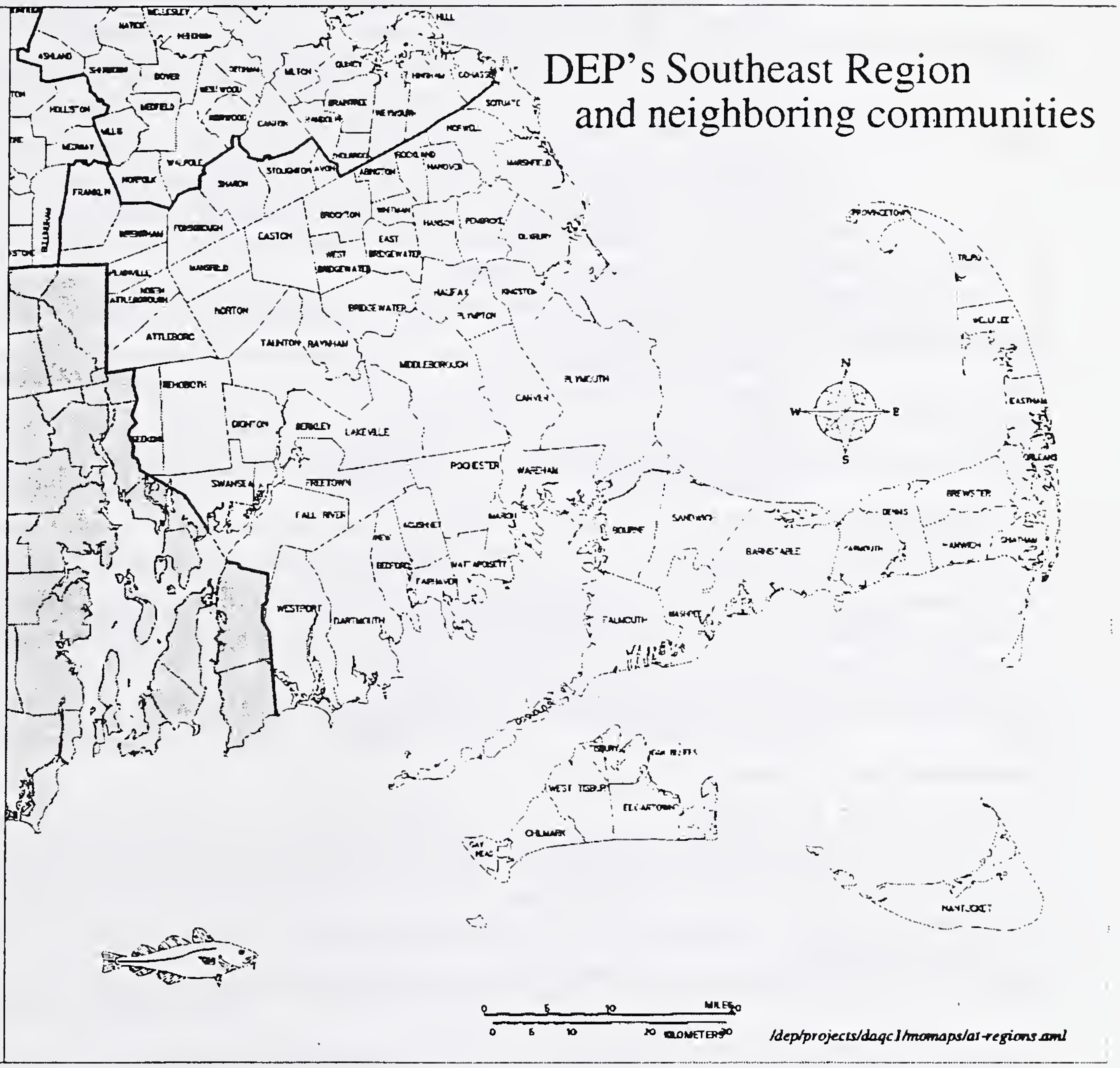
MADEP's Southeast Region Map

DEP –SERO (SOUTHEAST)
20 Riverside Drive
Lakeville, MA 02347
(508)946-2700

Paul Taurasi: Regional Director

DATA SOURCES:

Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS



National Ambient Air Quality Standards

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
SO_2	Annual Arithmetic Mean	0.03 ppm (80 ug/m^3)	None
	24-Hour	0.14 ppm (365 ug/m^3)	None
	3-Hour	None	0.50 ppm (1300 ug/m^3)
CO	8-Hour	9 ppm (10 mg/m^3)	Same as Primary Standard
	1-Hour	35 ppm (40 mg/m^3)	Same as Primary Standard
O_3	1-Hour	0.12 ppm (235 ug/m^3)	Same as Primary Standard
	8-Hour	0.08 ppm (157 ug/m^3)	Same as Primary Standard
• The 1-hour standard is met when the daily maximum 1-hour concentration does not exceed 0.12 ppm at any one monitor on more than 3 days over any 3 year period. • The 8-hour standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.08 ppm at any one monitor.			
Pb	Calendar Quarter Arithmetic Mean	1.5 ug/m^3	Same as Primary Standard
NO_2	Annual Arithmetic Mean	0.053 ppm 100 ug/m^3	Same as Primary Standard
$PM_{2.5}$ Particulates up to 2.5 microns in size	Annual Arithmetic Mean	15.0 ug/m^3	Same as Primary Standard
	24-Hour	65 ug/m^3	Same as Primary Standard
• The annual standard is met when the annual average of the quarterly mean $PM_{2.5}$ concentrations is less than or equal to 15 ug/m^3 (3-year average). If spatial averaging is used, the annual average from all monitors within the area may be averaged in the calculation of the 3-year mean. • The 24-hour standard is met when 98th percentile value is less than or equal to 65 ug/m^3 (3-year average).			
PM_{10} Particulates up to 10 microns in size	Annual Arithmetic Mean	50 ug/m^3	Same as Primary Standard
	24-Hour	150 ug/m^3	Same as Primary Standard
• The PM_{10} standard is based upon estimated exceedance calculations described in 40CFR Part 50, Appendix K. • The annual standard is met if the estimated annual arithmetic mean does not exceed 50 ug/m^3. • The 24-hour standard is attained if the estimated number of days per calendar year above 150 ug/m^3 does not exceed one per year.			

µg/m^3 = micrograms per cubic meter **ppm** = parts per million **mg/m^3** = milligrams per cubic meter

* Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

Pollutant Health Effects and Sources

Ozone (O_3)	• Ground-level and stratospheric O_3 are often confused. Stratospheric O_3 is beneficial because it filters out the sun's harmful ultraviolet radiation. However, ground-level O_3 is a health and environmental problem. This report pertains to ground-level O_3. • O_3 irritates mucous membranes. This causes reduced lung function, nasal congestion, and throat irritation, and reduced resistance to infection. • O_3 is toxic to vegetation, inhibiting growth and causing leaf damage. • O_3 weakens materials such as rubber and fabrics. • O_3 is unique in that it is formed by reactions between other pollutants in the presence of intense, high-energy sunlight occurring during the summer months. The complexity and subsequent time needed to complete these reactions results in the buildup of ground-level ozone concentrations far downwind from the original source of the precursors. • Sources of ground-level O_3 precursors, nitrogen oxides and hydrocarbons, include motor vehicles and power plants.
Carbon Monoxide (CO)	• CO reacts in the bloodstream with hemoglobin, reducing oxygen carried to organs and tissues. • Symptoms of high CO exposure include shortness of breath, chest pain, headaches, confusion, and loss of coordination. The health threat is most severe for those with cardiovascular disease. • High levels of CO are possible near parking lots and city streets with slow-moving cars, particularly during peak traffic times. • Motor vehicle emissions are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.
Sulfur Dioxide (SO_2)	• SO_2 combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis. • SO_2 is a primary contributor to acid deposition. Impacts of acid deposition include acidification of lakes and streams, damage to vegetation, damage to materials, degradation of visibility. • SO_2 is a product of fuel combustion (e.g., burning coal and oil). Sources include heat and power generation facilities and petroleum refineries.
Nitrogen Dioxide (NO_2)	• NO_2 lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis. • NO_2 contributes to acid deposition. [See SO_2 listing above for the effects.] • NO_2 and NO contribute to the formation of ozone. • NO_2 is formed from the oxidation of nitric oxide (NO). Major sources of NO are fuel combustion, heating and power plants, and motor vehicles.

Continued on next page

Particulate Matter (PM_{10} and $PM_{2.5}$)	• Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, soot, smoke, and liquid droplets. • The numbers 2.5 and 10 refer to the particle size, measured in microns, collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence. • The small size of the particles allows entry into the human respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and produces respiratory symptoms. • Particulate matter causes soiling and corrosion of materials. • Particulate matter contributes to atmospheric haze that degrades visibility. • Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, and motor vehicles.
Lead (Pb)	• Lead is an elemental metal. • The primary source for airborne lead used to be motor vehicles, but the use of unleaded gasoline has greatly reduced those emissions. Other sources are lead smelters and battery plants. • Exposure to lead may occur by inhalation or ingestion of food, water, soil or dust particles. • Children, infants, and fetuses are more susceptible to the effects of lead exposure. • Lead causes mental retardation, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.

Public and Industrial Monitoring Network Descriptions

2000 Public Monitoring Network

The Air Assessment Branch operates a public ambient air monitoring network.

Network size

- 40 monitoring stations
- 25 cities & towns with monitoring stations

Number of continuous monitors

Continuous monitors measure the air quality 24 hours a day. The data is reported as hourly means.

- Criteria pollutant monitors – these are pollutants for which National Ambient Air Quality Standards (NAAQS) have been set.
  - 8 – CO (carbon monoxide)
  - 13 – NO_2 (nitrogen dioxide). NO (nitrogen oxide) and NO_x (total nitrogen oxides) are also measured by these monitors.
  - 15 – O_3 (ozone)
  - 8 – SO_2 (sulfur dioxide)

- Meteorological monitors track weather conditions.
  - 10 – BP (barometric pressure)
  - 10 – RH (relative humidity)
  - 10 - SOLAR RAD (solar radiation)
  - 12 – TEMP (temperature)
  - 13 – WS/WD (wind speed/wind direction)
  - 1 – Upper Meteorology – this monitor measures WS/WD and TEMP at various altitudes. This aids in the analysis of pollutant transport.

- Other Monitors
  - 2 – NO_y (Total Reactive Oxidized Nitrogen)
  - 4 - PAMS (Photochemical Assessment Monitoring Station). These monitors measure VOCs (volatile organic compounds).
  - 1 – $PM_{2.5}$ (particulate matter – 2.5 microns)
  - 1- Black Carbon
  - 1- Teom/Camms (particulate matter – 2.5 microns)
  - 1 - Acid Deposition. Precipitation is collected and analyzed for conductivity and acidic compounds that are harmful to the environment. This monitor, located in Waltham, is part of the National Atmospheric Deposition Program (NADP). Two other monitors in Massachusetts are also part of the NADP. They are located in Truro and Ware and are not operated by MADEP.

Continued on next page

Number of intermittent monitors

- Other Monitors
  Intermittent monitors take discrete samples for a specific time period. The samples are taken every day, every third day, or every sixth day. The data is averaged in 3-hour or 24-hour intervals.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS).
  - 1 – Pb (Lead)
  - 11 - PM_{10} – (particulate matter – 10 microns)
  - 27 – $PM_{2.5}$ – (particulate matter – 2.5 microns)
- Non-criteria pollutant monitors – these pollutants do not have NAAQS.
  - 8 - PAMS (photochemical assessment monitoring station). These monitors measure VOCs (volatile organic compounds).
  - 1 – TSP (total suspended particulates)
  - 2 - Toxics. These monitors measure health-relevant VOCs.
  - 1 – Speciation. This monitors for $PM_{2.5}$, nitrates, and organics.

2000 Industrial Monitoring Network

Industries monitor air quality and submit data under agreement with MADEP. The data must be collected using quality assurance requirements established by MADEP and USEPA.

Network size

- 6 monitoring stations
- 3 cities and towns with monitoring stations

Number of continuous monitors

Continuous monitors measure the air quality 24 hours a day. The data is averaged to provide 1-hour averages.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS).
  - 1 – NO_2 (nitrogen dioxide). NO (nitrogen oxide) and NO_x (total nitrogen oxides) are also measured by this monitor.
  - 6 – SO_2 (sulfur dioxide)

- Meteorological monitors
  - 6 – WS/WD (wind speed/wind direction)

Number of intermittent monitors

Intermittent monitors take discrete samples for a specific time period. These monitors sample every sixth day, and the data is averaged for a 24-hour interval.

- Other Monitors
  - 4 – TSP (total suspended particulates)
  - 4 – SO_4 (sulfate)

Public Site Directory

CITY SITE LOCATION	DATE SITE ESTABLISHED	AIRS CODE	PARAMETERS MONITORED
ADAMS Mt. Greylock Summit	05/01/89	25-003-4002	O_3
AGAWAM 152 Westfield St.	01/01/82	25-013-0003	PAMS; O_3;NO_2;NO; NO_x; TEMP; WS/WD; SOLAR RAD; RH; BP
AMHERST N. Pleasant St.	04/01/88	25-015-0103	O_3
BOSTON Kenmore Square 590 Commonwealth Ave.	01/01/65	25-025-0002	SO_2; NO_2; NO; NO_x; CO; TEMP; PM_{10};TSP, Pb; $PM_{2.5}$
BOSTON Fire Headquarters Southampton St.	07/01/70	25-025-0012	PM_{10}
BOSTON 340 Bremen St. East Boston	01/01/[illegible]	25-025-0021	SO_2; NO_2; NO; NO_x; CO;
BOSTON Fire Station 200 Columbus Ave.	01/01/[illegible]	25-025-0024	PM_{10}
BOSTON 1 City Square Charlestown	01/01/85	25-025-0027	PM_{10}; $PM_{2.5}$
BOSTON Post Office Square	12/29/89	25-025-0038	CO
BOSTON Long Island	12/01/98	25-025-0041	O_3; NO; NO_2; NO_x; WS/WD; TEMP; SOLAR RAD; RH; BP; Toxics; PAMS
BOSTON 1129 Harrison Ave. Roxbury	12/15/98	25-025-0042	O_3; SO_2; NO_2; NO; NO_x; WS/WD; TEMP; SOLAR RAD; RH; BP; Black Carbon; $PM_{2.5}$; Toxics, Speciation Teom/Camms
BOSTON 174 North St. North End	01/01/00	25-025-0043	$PM_{2.5}$
CHICOPEE Westover Air Force Base	01/01/83	25-013-0008	PAMS; O_3; NO_2; NO; NO_x; TEMP; WS/WD; SOLAR RAD; RH;BP; $PM_{2.5}$
EASTON Borderland State Park	07/01/95	25-005-1005	PAMS; O_3; NO_2; NO; NO_x; WS/WD; TEMP; SOLAR RAD;RH; BP
FAIRHAVEN Wood School Scontuit Rd.	01/01/82	25-005-1002	O_3; WS/WD
FALL RIVER Fire Headquarters 165 Bedford St.	01/01/58	25-003-3001	$PM_{2.5}$

Continued on next page

CITY SITE LOCATION	DATE SITE ESTABLISHED	AIRS CODE	PARAMETERS MONITORED
FALL RIVER Fire Station Globe St.	02/01/75	25-005-1004	SO_2
FITCHBURG Fitchburg State College 67 Rindge St.	12/01/98	25-027-2004	$PM_{2.5}$
HAVERHILL Consentino School Washington St.	07/19/94	25-009-5005	$PM_{2.5}$
LAWRENCE Wall Experiment Station 37 Shattuck Street	04/03/99	25-009-6001	$PM_{2.5}$
LAWRENCE Storrow Park High St.	01/01/80	25-009-0005	O_3; SO_2; WS/WD
LOWELL Old City Hall Merrimack St.	07/17/81	25-017-0007	CO
LOWELL High School 50 French Street	10/31/00	25-017-0008	PM2.5
LYNN Lynn Water Treatment Plant 390 Parkland St.	01/01/92	25-009-2006	PAMS; O_3; NO_2; NO; NO_x,, WS/WD; TEMP; SOLAR RAD; RH; BP; $PM_{2.5}$
NEW BEDFORD YMCA 25 Water St.	01/01/84	25-005-2004	$PM_{2.5}$
NEWBURY US Department of the Interior Sunset Boulevard	08/01/84	25-009-4004	PAMS; O_3; NO_2; NO; NO_x; WS/WD; TEMP; SOLAR RAD; BP
PITTSFIELD Silvio Conte Federal Building 78 Center St.	12/01/98	25-003-5001	$PM_{2.5}$
QUINCY Fire Station Hancock St.	01/01/76	25-021-0007	$PM_{2.5}$
SPRINGFIELD Howard School 59 Howard Street	01/01/78	25-013-0011	PM_{10}
SPRINGFIELD Liberty St.	04/01/88	25-013-0016	SO_2; NO_2; NO; NO_x; CO; $PM_{2.5}$

Continued on next page

Public Site Directory, Continued

CITY SITE LOCATION	DATE SITE ESTABLISHED	AIRS CODE	PARAMETERS MONITORED
SPRINGFIELD 1586 Columbus Ave.	11/01/81	25-013-2007	CO; PM_{10}; $PM_{2.5}$
STOW U.S. Military Reservation	04/01/98	25-017-1102	O_3; Upper Meteorology; WS/WD; TEMP; BP; RH; SOLAR; $PM_{2.5}$
TRURO Cape Cod National Park Fox Bottom Area	04/01/87	25-001-0002	PAMS; O_3; NO_2; NO; NO_x; NOy; WS/WD; TEMP; BP; RH; SOLAR RAD
WALTHAM U. Mass Field Station Beaver St.	01/01/71	25-017-4003	Acid Deposition
WARE Quabbin Summit	06/01/85	25-015-4002	PAMS; O_3; SO_2; NO_2; NO; NO_x; NOy; PM_{10}; WS/WD; TEMP; BP; RH; SOLAR RAD; $PM_{2.5}$; PM_{10}
WORCESTER Worcester Airport	05/07/79	25-027-0015	O_3; WS/WD; TEMP
WORCESTER YWCA 2 Washington St.	01/01/78	25-027-0016	PM_{10}; $PM_{2.5}$
WORCESTER Fire Station Central St.	01/01/82	25-027-0020	SO_2; NO_2; NO; NO_x; CO; $PM_{2.5}$
WORCESTER Grafton and Franklin Sts.	07/28/92	25-027-0022	CO

Industrial Site Directory

REPORTING ORGANIZATION CITY SITE LOCATION	DATE SITE ESTABLISHED	AIRS CODE	PARAMETERS MONITORED
ATLANTIC GELATIN Stoneham (Hill St.) Hill Street	01/01/78	25-017-1701	SO_2; WS/WD
SITHE NEW ENGLAND Boston Long Island	01/01/78	25-025-0019	SO_2; WS/WD; TSP; SO_4
SITHE NEW ENGLAND Dorchester Dewar Street	01/01/78	25-025-0020	SO_2; WS/WD; TSP; SO_4
SITHE NEW ENGLAND East Boston Bremen Street	01/01/79	25-025-0021	SO_2; WS/WD; TSP; SO_4
SITHE NEW ENGLAND South Boston East First Street	01/01/93	25-025-0040	SO_2; NO_2; NO; NO_x; WS/WD; TSP; SO_4
HAVERHILL PAPERBOARD Haverhill Nettle School	09/10/85	25-009-5004	SO_2; WS/WD

Air Quality Related Web Sites

Web sites of interest

The table below is a listing of internet web sites that have air quality data or related information.

Web Address	Organization	Description
mass.gov/dep/	MADEP	Massachusetts DEP Home Page. Links to MADEP programs, regions and publications. Links to the Daily Ozone Forecast during ozone season (May1 through September 30).
mass.gov/dep/bwp/daqc/	MADEP	MADEP Air Program Planning Unit Home Page.
mass.gov/dep/bwp/dhm/tura	MADEP	Toxic Use Production Program –establishes toxics use reduction as the preferred means for achieving compliance with any federal or state law or regulation pertaining to toxics production and use.
www.airbeat.org	MADEP/EMPACT	Current AIR Quality in Roxbury – web page of MADEP and EMPACT's Roxbury monitor that shows current levels of ozone and particulates in the air.
www.turi.org	TURI	Toxics Use Reduction Institute –a multi-disciplinary research, education, and technical support center located at the University of Massachusetts/Lowell. Promotes reduction in the use of toxic chemicals and the generation of toxic by-products in industry and commerce in Massachusetts. The web site includes a link to TURAData, which makes information available to the public about toxics use in their communities.
www.epa.gov/airnow/ozone.html	USEPA	Ozone Mapping Project – color-coded animated maps using near real-time data that show how ozone is formed and transported downwind.
www.epa.gov/region01/eco/dailyozone/ozone.html	USEPA	Ozone maps of the Northeast U.S. using near real-time data.
www.epa.gov/region01/eco/ozone/smogalrt	USEPA	EPA Smog Alert System – sign up and receive e-mail alerts whenever Massachusetts predicts unhealthy ozone levels.
www.epa.gov/air/data/	USEPA	AIRSData - Access to air pollution data for the entire U.S.
www.epa.gov/ceis/	USEPA	Center for Environmental Information and Statistics – a single convenient source for information on environmental quality.
www.epa.gov/oar/oaqps	USEPA	EPA's Office of Air and Radiation/Office of Air Quality Planning and Standards
www.epa.gov/region01	USEPA	EPA Region 1 Home Page
www.epa.gov/ttn/	USEPA	EPA Technology Transfer Network - a collection of technical Web sites containing information about many areas of air pollution science, technology, regulation, measurement, and prevention.

Continued on next page

Web sites of interest, continued

The table below is a listing of internet web sites that have air quality data or related information.

Web Address	Organization	Description
www.epa.gov/enviro/ index_java.html	USEPA	EPA Envirofacts – data extracted from (4) major EPA databases: • PCS (Permit Compliance System) • RCRIS (Resource Conservation and Recovery Information System) • CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) • TRIS (Toxic Release Inventory System)
es.epa.gov/index.html	USEPA	Enviroene Network - a free, public environmental information system. Provides users with pollution prevention/cleaner production solutions, compliance and enforcement assistance information, and innovative technology options.
www.epa.gov/docs/ ozone/index.html	USEPA	EPA Ozone Depletion Home Page – learn about the importance of the "good" ozone in the stratospheric ozone layer.
www.epa.gov/acidrain/	USEPA	The Acid Rain Program – overall goal is to achieve significant environmental and public health benefits through reductions in emissions of sulfur dioxide (SO2) and nitrogen oxides (NOX), the primary causes of acid rain. Emissions data from the nation's largest power generating facilities is available here.
Maine janus.state.me.us/dep/ air/ozone.htm New Hampshire www.des.state.nh.us/ ard/ozone.htm New York www.dec.state.ny.us/ website/dar/bts/ozone/ oz4cast.html New Jersey www.state.nj.us/dep/ airmon/ Rhode Island www.state.ri.us/dem/ ozone/ozoneday.htm		Ozone predictions and some real-time ozone data from neighboring states (some states report other pollutants, as well).

Continued on next page

Air Quality Related Web Sites, Continued

Web sites of interest, continued

The table below is a listing of internet web sites that have air quality data or related information.

Web Address	Organization	Description
www.epa.gov/ttn/uatw/	USEPA	Unified Air Toxics Website - This site is a central clearinghouse and repository for air toxics implementation information
www.epa.gov/airtrends	USEPA	AIRTrends - information on USEPA's evaluation of status and trends in the nation's outdoor air quality.
www.4cleanair.org/ links.html	STAPPA/ALAPCO	State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials – site has links to air quality related agencies and organizations.
www.nescaum.org/	NESCAUM	Northeast States for Coordinated Air Use Management – an interstate association of air quality control divisions from the six New England states, New York and New Jersey.
www.wunderground. com/	University of Michigan	The Weather Underground -. another good source of weather information in the US and world.
cirrus.sprl.umich.edu/ wxnet	University of Michigan	The WeatherNet – a good source of weather information. Also has a great list of weather links.
www.nws.noaa.gov/er/ box	NWS	The National Weather Service's Boston office provides local forecasts and climate information.
www.wcvb.com/ weather/pollencount/	WCVB	WCVB TV Pollen Count – provides the daily pollen and mold count.
www.hazecam.net/	NESCAUM (CAMNET)	Real-time Air Pollution Visibility Camera Network - live pictures and air quality conditions for urban and rural vistas across the Northeast U.S.
www.arb.ca.gov/homepage.h tm	CARB	California Air Resources Board Home Page
www.awma.org/	AWMA	The Air & Waste Management Association - a nonprofit, nonpartisan professional organization that provides training, information, and networking opportunities to 12,000 environmental professionals in 65 countries.
nadp.sws.uiuc.edu/	NADP	National Atmospheric Deposition Program – maps and data from the nationwide precipitation monitoring network. Site also has data from the Mercury Deposition Network.
www.lungusa.org/ index	American Lung Association	American Lung Association – public health advocacy organization involved in public policy, research, and education mission is to prevent lung disease

Section II

Attainment and Exceedances of Air Quality Standards

Attainment Status Summary

What determines attainment status?

The National Ambient Air Quality Standards (NAAQS) promulgated by USEPA set the concentration limits that determine the attainment status for each criteria pollutant. The NAAQS are listed on page 16. Massachusetts does not attain the public health standard for two pollutants: ozone (O_3) for the entire state and carbon monoxide (CO) in a few cities. The attainment status for O_3 and CO is described in this section.

CO attainment status

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996.

MADEP has requested that the USEPA redesignate the cities of Lowell, Springfield, Waltham, and Worcester to attainment for CO because monitoring data has been below the standard for many years. The USEPA has not yet ruled upon this request.

Revision of the ozone (O_3) standard

In July 1997, USEPA revised the O_3 standard to include an 8-hour average. This provides increased health protection against longer-term exposures to O_3 at lower concentrations.

When USEPA finalized the 8-hour O_3 NAAQS, it determined that the existing 1-hour O_3 standard would remain in place until an area monitored had no violations. Therefore, when an area no longer violated the 1-hour O_3 standard, USEPA would revoke that standard for the area, and only the 8-hour O_3 standard would apply. This procedure was intended to provide a smooth transition to the 8-hour O_3 standard.

When the O_3 standard was revised, it was challenged in court. Below is an outline of this and related rulings.

- May 14, 1999: In response to challenges filed by industry and others, the Washington D.C. Circuit Court of Appeals ruled that, although the 8-hour O_3 standard is retained, USEPA can not enforce it.
- June 9, 1999: The 1-hour O_3 standard was revoked for Eastern Massachusetts (including Worcester county and east) in a ruling published by the USEPA. These areas had no violations of the 1-hour O_3 standard during the period 1996–1998.
- October 25, 1999: Reacting to the May 1999 court ruling, USEPA proposed to reinstate the 1-hour O_3 standard in all areas where it had been revoked, including Eastern Massachusetts.

Continued on next page

Revision of the Ozone (O_3) Standard, cont.

- July 20, 1999: USEPA issued a final ruling reinstating the 1-hour O_3 standard and the prior classification (i.e., serious non-attainment) for Eastern Massachusetts. The rule became effective in January 2001.
- November 7, 2000: The US Supreme Court heard oral arguments in USEPA's appeal of the Washington D.C. Circuit Court of Appeals' May 1999 decision. The main questions were whether setting a NAAQS under the Clean Air Act (CAA) is an unconstitutional delegation of legislative power by Congress, and whether one section of the CAA, which sets the requirements for areas in non-attainment of the 1-hour O_3 standard, has the effect of prohibiting USEPA from enforcing the 8-hour O_3 standard.
- February 27, 2001: Ruling made by the US Supreme Court upheld the USEPA's revised O_3 (and $PM_{2.5}$) NAAQS, but remanded to The District Court for consideration of implementation issues.

One-hour O_3 Attainment status

Massachusetts' 1-hour O_3 standard attainment status has changed several times since July 1997 (see above), when the 8-hour standard was instituted. At that time, the designation for all of Massachusetts was non-attainment for the 1-hour O_3 standard.

Eight-hour O_3 attainment status

In 1997, the USEPA adopted a new 8-hour ozone standard, which became the subject of litigation. As part of the designation process for the new standard, then Governor Celluci submitted a letter to the USEPA in July 2000. Based on 8-hour ozone data for the three-year period 1997-1999, he recommended that Eastern and Western Massachusetts be designated "non-attainment" under the new standard.

Litigation related to the new standard continues and the USEPA has not made formal designations of attainment areas. In February 2001, the US Supreme Court upheld the new standards but remanded a number of legal issues back to the D.C. Circuit Court for reconsideration. There is no timetable for implementation of the new standards in light of the ongoing legal action.

Ozone Exceedances

What determines an exceedance?

An O_3 exceedance occurs when a daily O_3 concentration exceeds the National Ambient Air Quality Standards (NAAQS). There are two O_3 standards based on different averaging times, 1 hour and 8 hours. An exceedance of the 1-hour standard is an hourly value during a day that is equal to or greater than 0.125 ppm. An exceedance of the 8-hour standard is an 8-hour averaged value during a day that is equal to or greater than 0.085 ppm.

The difference between an exceedance and a violation

Recording an exceedance of the O_3 standards does not necessarily mean that a violation of the standard has occurred. Violations of the 1-hour and 8-hour standards are based upon 3-year averages of O_3 data, as explained below.

Violations of the 1-hour standard are determined using the number of expected exceedance days. An exceedance day is a day that records an O_3 1-hour average greater than the standard of 0.12 ppm. A monitoring site can only have one reported exceedance per day – the hour with the highest average is used. The term "expected exceedance days" is used to account for both actual exceedance days and missing data.
A violation of the 1-hour standard requires a 3-year average that is greater than one expected exceedance day. In other words, if there are 4 or more days during a 3-year period with O_3 1-hour values that are equal to or greater than 0.125 ppm, a violation of the 1-hour standard has occurred.

Violations of the 8-hour standard are determined using the annual 4th-highest daily maximum 8-hour O_3 value. A violation requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. In other words, the highest 8-hour value for each day during a year is ranked from highest to lowest. Then, the 4th-highest value for 3 consecutive years is averaged. If the 3-year average is 0.085 ppm or greater, a violation of the 8-hour standard has occurred.

O_3 exceedances and violations during 2000

During 2000, there was one exceedance day and one exceedance of the 1-hour standard. There were 5 exceedance days and 15 exceedances of the 8-hour standard.

Using data from 1998–2000, only one out of 15 sites violated the 1-hour standard. The more stringent 8-hour standard was violated at all 15 of the 15 sites for the 1998-2000 period.

Continued on next page

2000 O_3 Exceedances (ppm)

DATE	SITE	8-HOUR EXC	1-HOUR EXC
June 9, 2000	TRURO	.094	
June 10, 2000	ADAMS	.090	
June 10, 2000	AGAWAM	.089	
June 10, 2000	AMHERST	.086	
June 10, 2000	CHICOPEE	.090	
June 10, 2000	FAIRHAVEN	.105	
June 10, 2000	LYNN	.089	
June 10, 2000	STOW	.099	
June 10, 2000	TRURO	.126	
June 10, 2000	WARE	.091	
June 10, 2000	WORCESTER	.095	
June 10, 2000	TRURO		.141
June 16, 2000	WARE	.089	
July 2, 2000	FAIRHAVEN	.090	
August 8, 2000	FAIRHAVEN	.085	
August 8, 2000	TRURO	.091	

Exceedance days and total exceedance trends

The following figures show the recent trends in exceedance days and the total number of 1-hour and 8-hour exceedances.

The trend for the 1-hour data in Figure 12 shows a decline in the number of exceedances and exceedance days over the period. The trend in Figure 13 shows that, under the new more stringent 8-hour standard, there are a greater number of exceedances and exceedance days compared to the 1-hour standard.

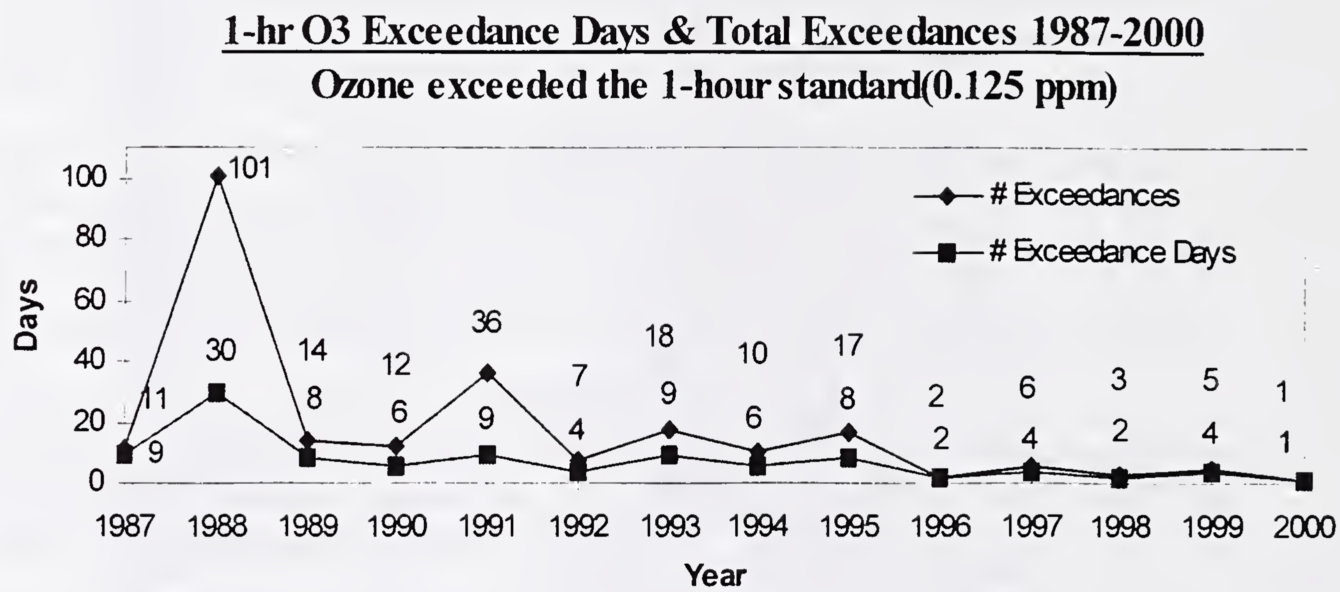


Figure 1

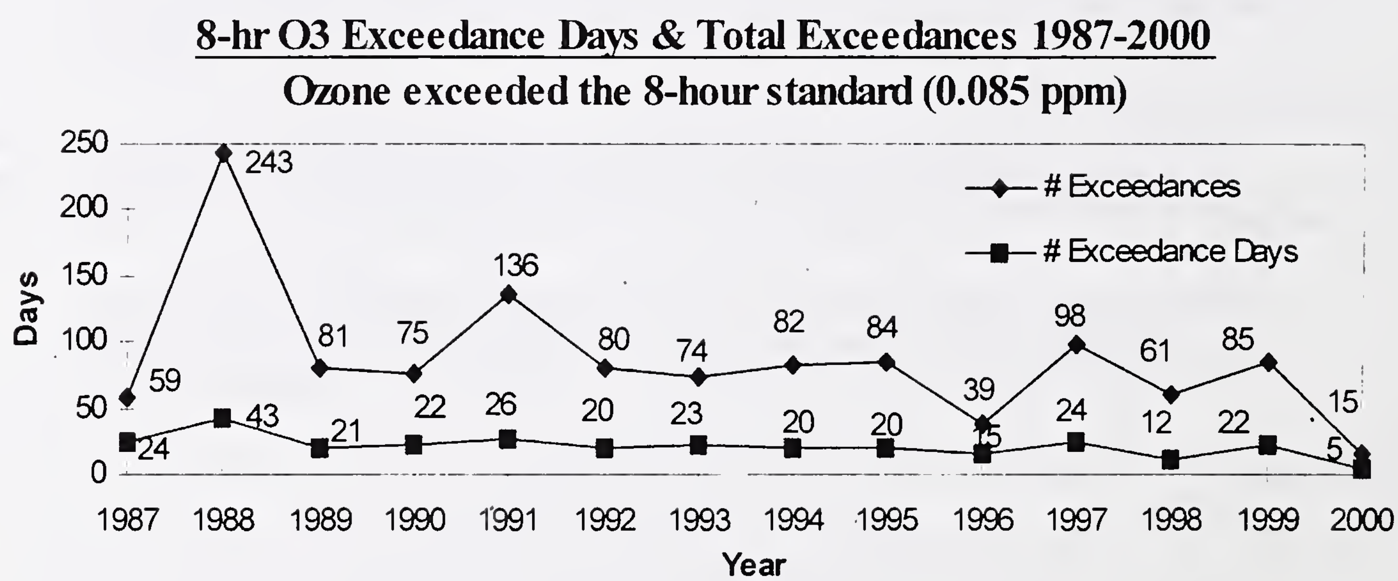


Figure 13

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1-hour O_3 violations

A violation of the 1-hour standard requires a 3-year average greater than one for the number of expected exceedance days (the daily maximum O_3 value exceeds 0.12 ppm). In July 2000, the USEPA reinstated the 1-hour standard. Massachusetts remains in non-attainment of the O_3 standard in the western region of the state, including Berkshire, Franklin, Hampden, and Hampshire counties.

Figure 14 shows the 3-year average of expected 1-hour exceedances at Massachusetts' sites for the period 1998–2000. None of the sites was in violation of the 1-hour standard during this period. Figure 15 shows the decrease in the number of 1-hour violation sites in Massachusetts during the last 13 years.

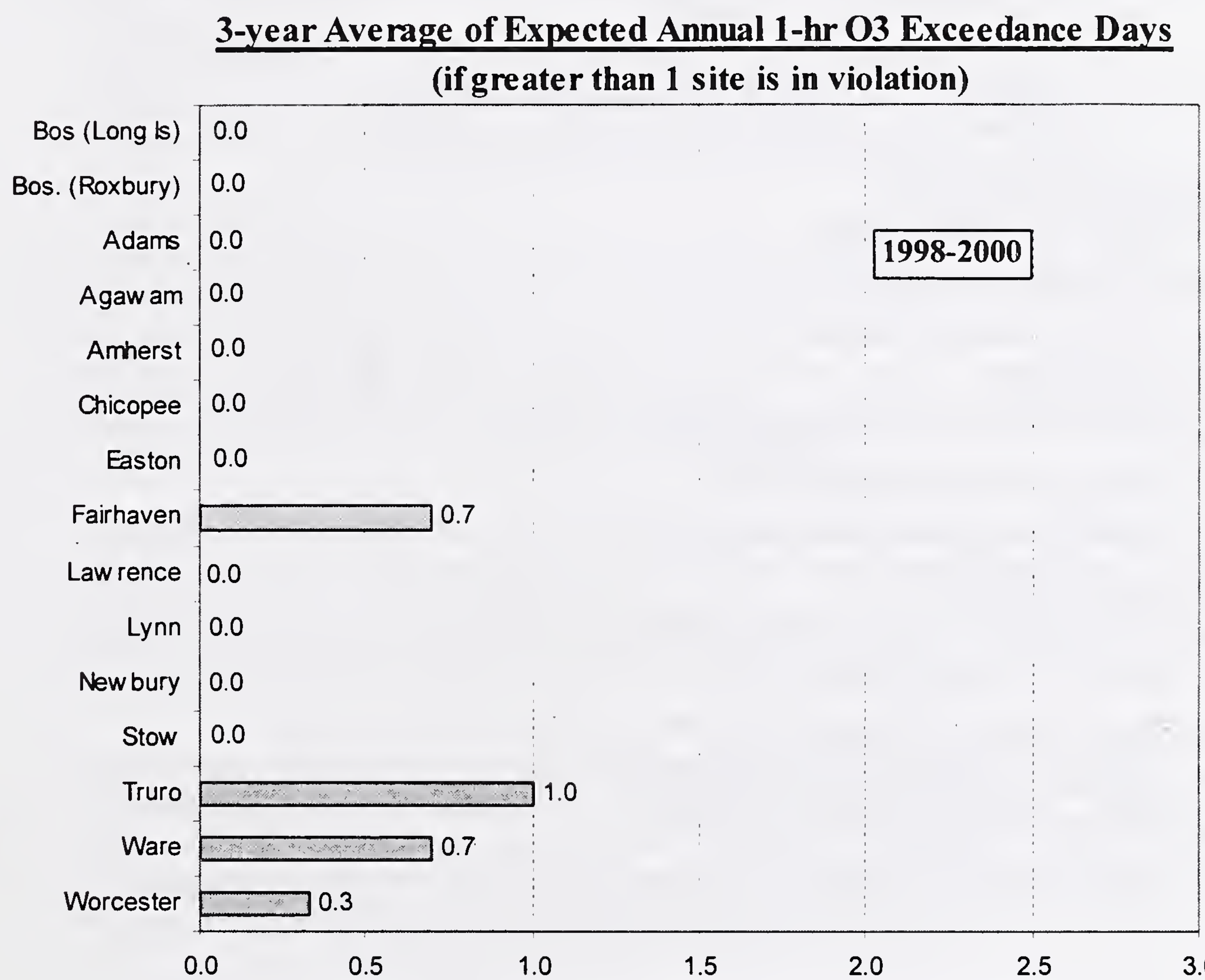


Figure 14

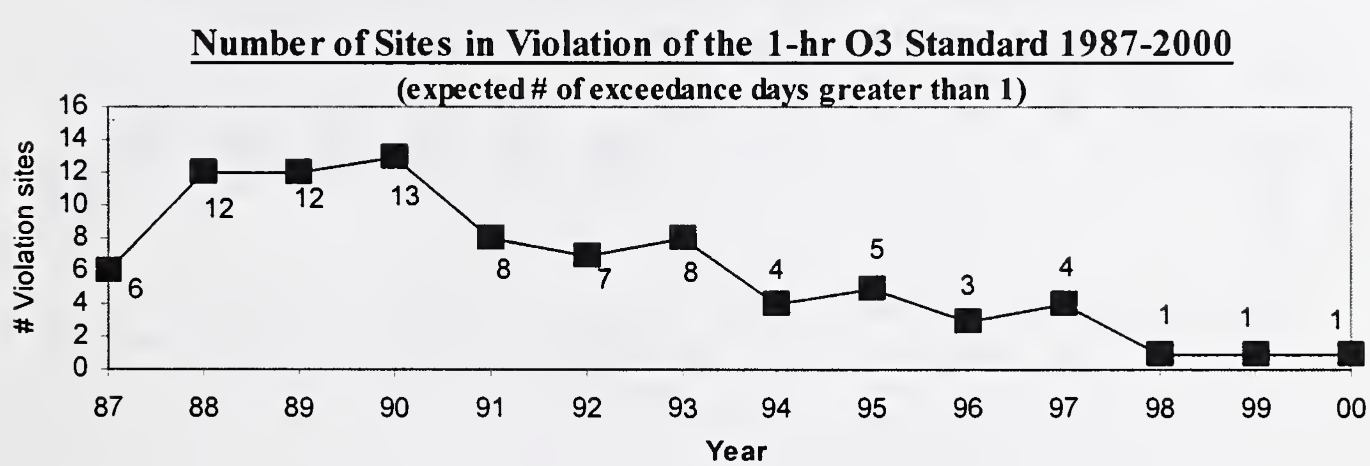


Figure 15

8-hour O_3 violations

A violation of the 8-hour standard requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. The standard became effective in 1997, so 1997-1999 was the first period to be used to designate attainment status.

Based upon the period 1998–2000, seven of the 15 sites with 3 years of data were in violation of the 8-hour standard. Figure 16 shows the 8-hour violation status for the 1998-2000 period. Figure 17 shows the trend for the number of violation sites from 1987-2000. The year reported is the final year of the 3-year running average. The number of violation sites has decreased.

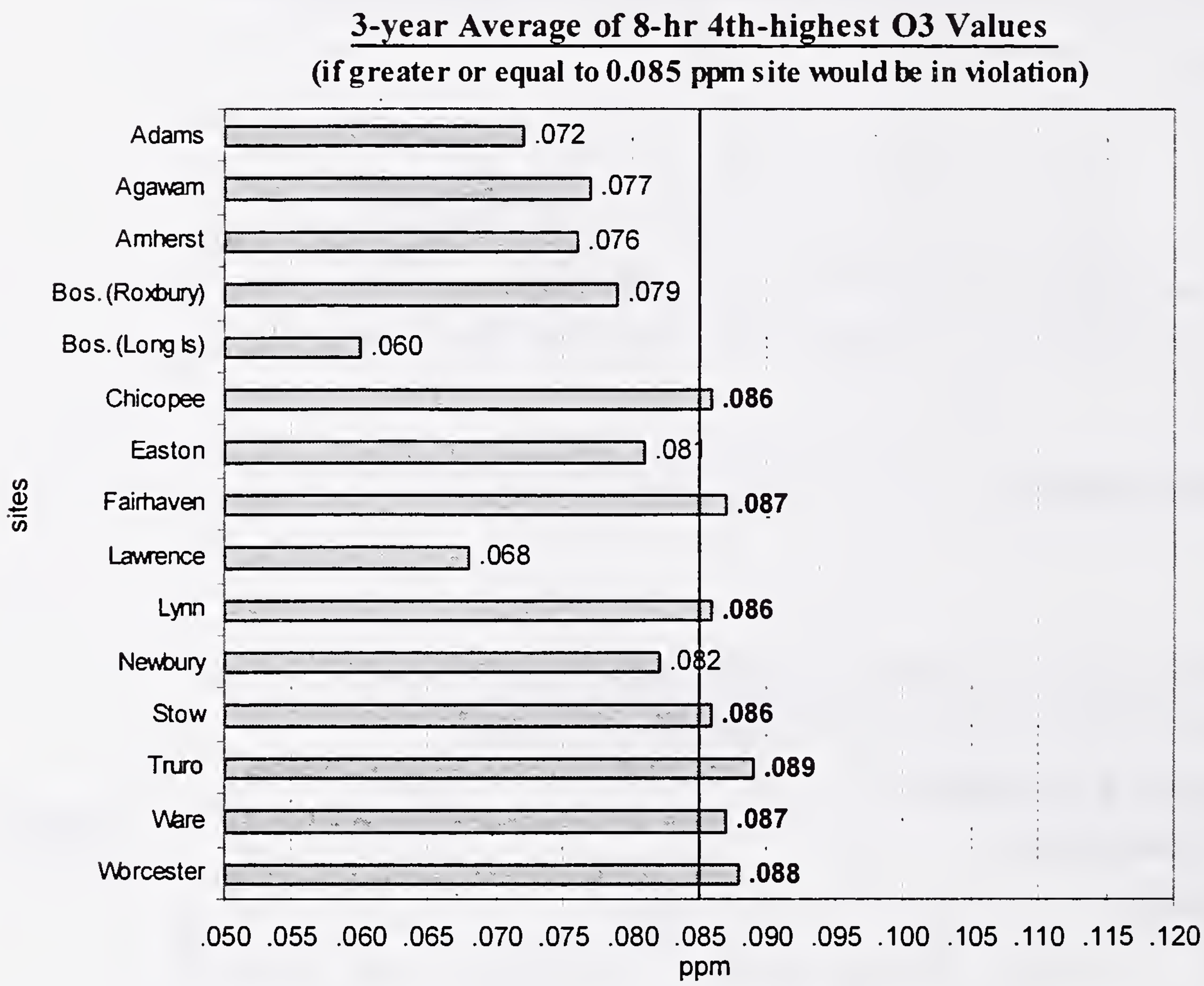


Figure 16

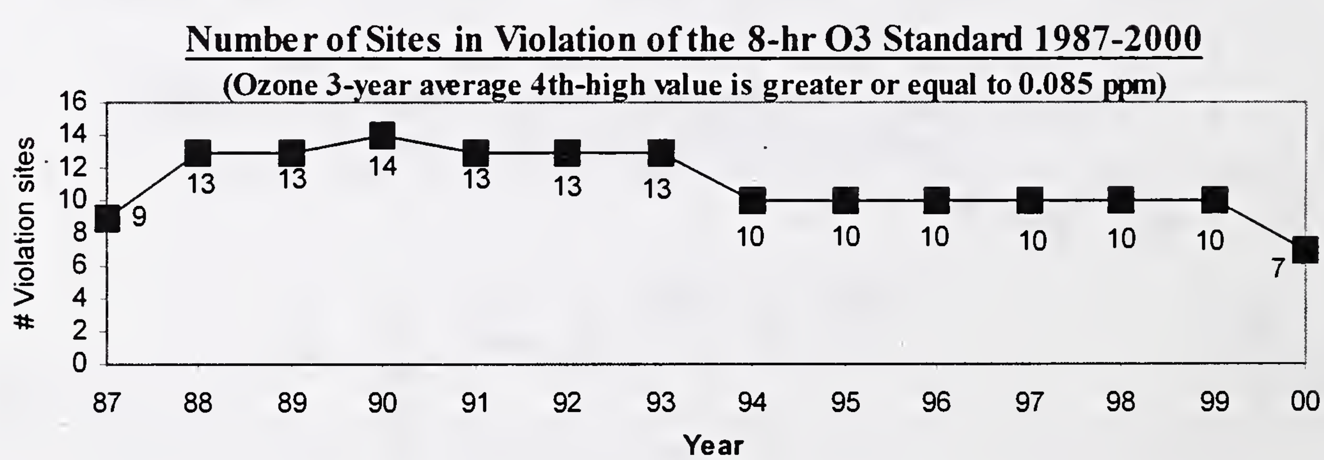


Figure 17

A Look at the 2000 Ozone (O_3) Season

Ozone and weather during 2000

The 2000 ozone season (May through September) in Massachusetts had the fewest high-concentration values since the state started monitoring ozone in 1973. MADEP measured 8-hour exceedances on only five days during the 2000 season, in contrast to 12 days of measured exceedances in 1998, the previous lowest year.

Better control of chemical precursors (including VOCs and NOx) has undoubtedly led to the downward trend in exceedances of ozone NAAQS standards in recent years. However, key components of summertime meteorology conducive to high ozone production were largely absent for most of 2000. Although chemical precursors are present in the atmosphere throughout the year, only the combination of intense sunlight, hot temperatures and southwesterly wind (from other Eastern Seaboard Metropolitan Areas to the southwest) during the summer can produce a buildup of ground level ozone to unhealthful concentrations. In fact, it is unnecessary to operate most of the ozone monitoring network from October through March.

Sustained hot weather periods failed to materialize consistently during the summer of 2000. Upper atmospheric winds, which move weather systems across the country, usually weaken during the summer, enabling slower movement of air masses, which fosters the buildup of air pollution levels. However, during the summer of 2000, these upper winds stayed strong, which resulted in below-normal temperatures, frequent rains, and many air-mass changes in New England. Such conditions are not conducive to the formation of high ozone concentrations.

Although ozone concentrations overall were lower than normal during 2000, summertime weather did break through during short periods, resulting in the recorded 8-hour exceedances. Highest levels were recorded at the Cape Cod site in Truro, which has been the focus of ozone exceedances in eastern Massachusetts over the last several seasons.

Although the 2000 summer was cool with low ozone concentrations, some other Massachusetts summers have been hot with above-normal frequency of 90-degree days and higher ozone concentrations. The influence of meteorology on ozone concentrations in 2000 and in years past makes the evaluation of long-term-concentration trends and control strategies a significant challenge.

Daily Ozone (O_3) Forecast

Introduction

MADEP forecasts air quality daily, based on O_3, from May through September. Each day during that period, MADEP predicts the air quality as good, moderate, or unhealthy.

Determining the air quality level rating

The air quality rating is determined through analysis of National Weather Service observations and modeled predictions. Meteorological, O_3, and nitrogen oxides data from the statewide and regional monitoring networks are also used.

The air quality ratings

The table below gives information about the ratings used in the daily air quality forecasts.

Air Quality Rating	Adverse Health Effects	Ways to Protect Your Health
Good	None expected.	No precautions necessary.
Moderate	O_3 levels in the upper part of this range may cause respiratory problems in some children and adults engaged in outdoor activities. These effects are of particular concern for those with existing lung problems.	People with respiratory diseases, such as asthma, and other sensitive individuals should consider limiting outdoor exercise and strenuous activities during the afternoon and early evening hours, when O_3 levels are highest.
Unhealthy	As O_3 levels increase, both the severity of the health effects and the number of people affected increase. Health effects include nose and throat irritation; chest pain; decreased lung function; shortness of breath; increased susceptibility to respiratory infection, and aggravation of asthma. It is important note that individuals react differently when exposed to various O_3 levels in the unhealthy range; some people experience problems at lower unhealthy levels, while others may not be affected until higher levels are reached.	In general, everyone should limit strenuous outdoor activity during the afternoon and early evening hours, when O_3 levels are usually the highest. If you are particularly sensitive to O_3, or if you have asthma or other respiratory problems, stay in an area where it is cool and, if possible, where it is air-conditioned. If you want to take action to minimize exposure to unhealthy O_3 levels, you should consider scheduling outdoor exercise and children's outdoor activities in the morning hours, when O_3 levels are generally lower.

Continued on next page

Daily Ozone (O3) Forecast, Continued

Forecast availability The daily air quality forecast is available May through September from MADEP's website (mass.gov/dep/) or by calling the Air Quality Hotline (1-800-882-1497).

Ozone maps USEPA maintains internet web sites containing current and archived O_3 maps and "real-time" O_3 movies using O_3 data that is provided by participating states: (www.epa.gov/region01/eco/dailyozone/ozone) and (www.epa.gov/airnow/ozone).

State Implementation Plan (SIP)

Overview

The federal Clean Air Act requires states that are in non-attainment of a standard to develop and implement strategies to attain that standard. The State Implementation Plan (SIP) is the mechanism for documenting this process, and all revisions to the SIP must be approved by USEPA.

Reasonable Further Progress SIPs

The following list contains the measures that have been submitted to the USEPA since 1993 as part of Massachusetts' "Reasonable Further Progress" toward attaining the ozone standard. Note that this is not a comprehensive list of air regulations, as there are many MADEP air regulations that are not specifically credited in the "Reasonable Further Progress" SIPs.

Air Pollution Programs that Demonstrate Reasonable Further Progress Toward O_3 Attainment

Stationary Point Source Controls:
- Reasonably Available Control Technology (RACT) for 50 Ton VOC Sources (310 CMR 7.18)
- RACT for 50 Ton NO_x Sources (310 CMR 7.19)

Stationary Area Source Controls:
- Reformulated Architectural and Industrial Maintenance Coatings (310 CMR 7.25)
- Reformulated Traffic Markings (310 CMR 7.25)
- Reformulated Consumer and Commercial Products (310 CMR 7.25)
- Automotive Refinishing Controls (310 CMR 7.18)

On-Road Mobile Source Controls:
- Stage II Vapor Recovery Systems at Gasoline Stations (310 CMR 7.24)
- Federal Reformulated Gasoline
- Enhanced Automobile Inspection and Maintenance (I/M) up to 10,000 Gross Vehicle Weight Rating (310 CMR 60.02)
- Low Emission Vehicle (LEV) Program (310 CMR 7.40)
- Federal Motor Vehicle Program (FMVCP) - Pre-Clean Act New Engine Performance Standards
- Federal Tier I New Engine Performance Standards
- Traffic Flow Improvements

Off-Road Mobile Source Controls:
- Federal Reformulated Gasoline for Off-Highway Equipment
- Federal New Engine Performance Standards for Off-Highway Equipment

Continued on next page

Attainment Demonstration SIP

In July 1998, MADEP submitted an Attainment Demonstration SIP to USEPA. In it, MADEP demonstrated that some additional VOC and NO_x reductions in Massachusetts, coupled with large-scale regional NO_x reductions, would likely allow Massachusetts to attain the one-hour O_3 standard.

The VOC and NO_x reduction in Massachusetts will come from:
- Additional federal measures (e.g., off-road and locomotive engine standards)
- Final implementation of Massachusetts' previous SIP commitments (e.g., Enhanced Vehicle I/M, which began operation in fall 2000)
- Enhancement of Massachusetts Stage II enforcement program
- Municipal Waste Combustor NO_x Reductions (310 CMR 7.08 (2))
- NO_x Allowance Trading Program (310 CMR 7.27 and 310 CMR 7.28)

MADEP also expects that the regional NO_x reductions will be achieved through compliance with the program known as EPA's "NO_x SIP Call" (63 FR 57356). It requires more than 20 eastern states to reduce NO_x emissions by May 2003.

Section III

Massachusetts Air Quality Data Summaries

Ozone (O_3) Summary

Introduction

There were 15 O_3 sites during 2000 in the state-operated monitoring network.

O_3 health effects and sources

- Ground-level and stratospheric O_3 are often confused. Stratospheric O_3 is beneficial because it filters out the sun's harmful ultraviolet radiation. However, ground-level O_3 is a health and environmental problem. This report pertains to ground-level O_3.
- O_3 irritates mucous membranes. This causes reduced lung function, nasal congestion, and throat irritation, and reduced resistance to infection.
- O_3 is toxic to vegetation, inhibiting growth and causing leaf damage.
- O_3 weakens materials such as rubber and fabrics.
- O_3 is unique in that it is formed by reactions between other pollutants in the presence of intense, high-energy sunlight during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground-level ozone concentrations far downwind from the original source of the precursors.
- Sources of ground-level O_3 precursors, nitrogen oxides and hydrocarbons, include motor vehicles and power plants.

The O_3 standard

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health from adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME	PRIMARY	SECONDARY
O_3	1-Hour	0.125 ppm (235ug/m³)	Same as Primary Standard
	8-Hour	0.085ppm (157 ug/m³)	Same as Primary Standard

- The 1-hour standard applies to the entire state. The standard is met when the expected exceedance days (the daily maximum 1-hour concentration exceeds 0.125 ppm) do not exceed one per year (3-year average) at any one monitor.
- The 8-hour standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.085 ppm at any one monitor.

μg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

Continued on next page

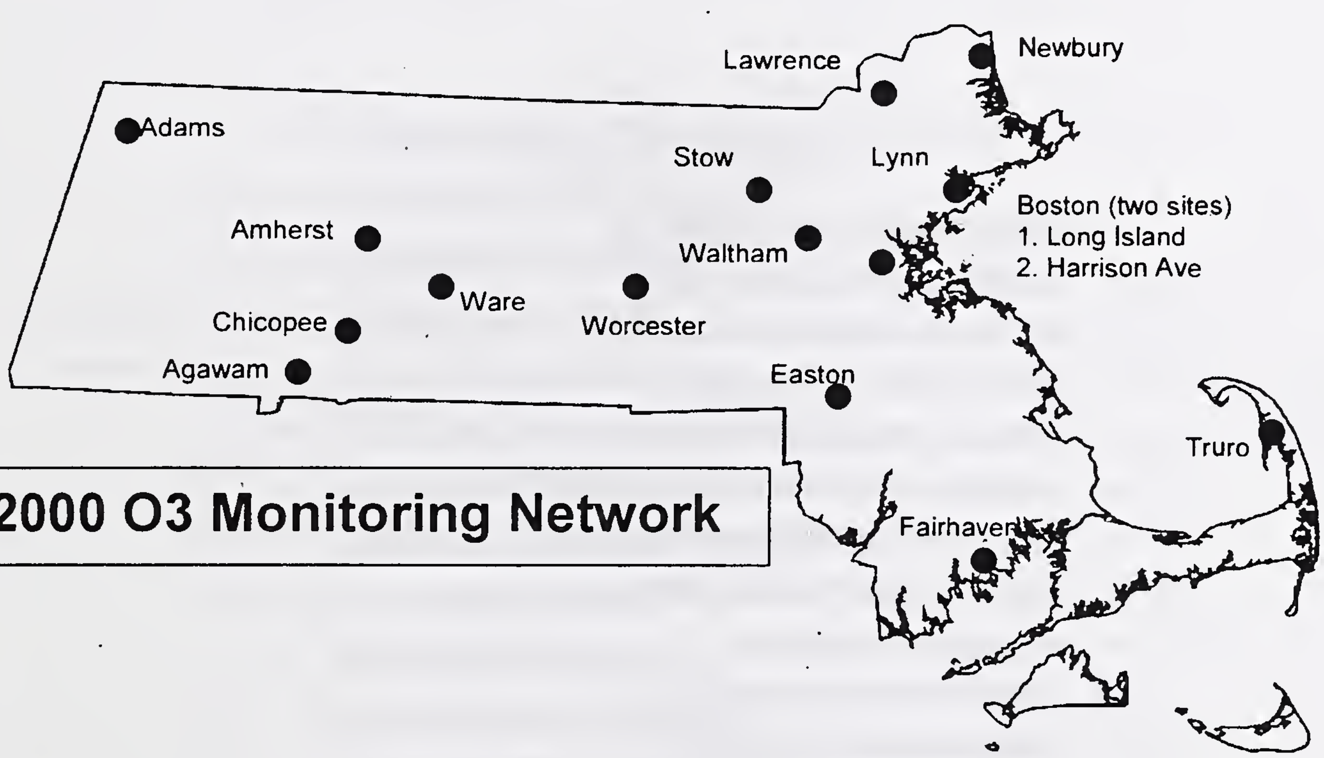
Ozone (O3) Summary, Continued

2000 O_3 data summary

A summary of the 2000 data during O_3 season (April 1 – Sept. 30) is listed below. All of the sites achieved the requirement of 75% or greater data capture for the year.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS: PPM)	% OBS	-1 HR MAX- 1ST	2ND	VALS >.125	-8-HR MAXIMA- 1ST	2ND	4TH	VALS >.085
25-003-4002	1	2	ADAMS	BERKSHIRE	MT. GREYLOCK	81	.092	.088	0	.090	.078	.072	1
25-013-0003	1	8	AGAWAM	HAMPDEN	152 S. WESTFIELD	93	.098	.096	0	.089	.080	.071	1
25-015-0103	1	2	AMHERST	HAMPSHIRE	NORTH PLEASANT	96	.095	.090	0	.086	.082	.065	1
25-025-0041	1	2	BOSTON	SUFFOLK	LONG IS. HOSPITAL	94	.092	.089	0	.084	.076	.072	0
25-025-0042	1	2	BOSTON	SUFFOLK	HARRISON AVE	98	.091	.078	0	.081	.062	.061	0
25-013-0008	1	7	CHICOPEE	HAMPDEN	ANDERSON ROAD	97	.113	.099	0	.090	.084	.079	1
25-005-1005	1	7	EASTON	BRISTOL	BORDERLAND PARK	92	.098	.088	0	.081	.077	.072	0
25-005-1002	1	2	FAIRHAVEN	BRISTOL	L. WOOD SCHOOL	93	.114	.101	0	.105	.090	.082	3
25-009-0005	1	1	LAWRENCE	ESSEX	HIGH STREET	95	.082	.072	0	.067	.062	.060	0
25-009-2006	1	8	LYNN	ESSEX	390 PARKLAND AVE	96	.100	.085	0	.089	.073	.070	1
25-009-4004	1	7	NEWBURY	ESSEX	SUNSET BOULEVARD	96	.097	.085	0	.082	.074	.071	0
25-017-1102	1	2	STOW	MIDDLESEX	US MILITARY RESERV.	90	.102	.086	0	.099	.077	.073	1
25-001-0002	1	2	TRURO	BARNSTABLE	FOX BOTTOM AREA	97	.141	.107	1	.126	.094	.083	3
25-015-4002	1	7-	WARE	HAMPSHIRE	QUABBIN SUMMIT	96	.104	.096	0	.091	.089	.076	2
25-027-0015	1	1	WORCESTER	WORCESTER	WORCESTER AIRPORT	96	.098	.098	0	.095	.081	.076	1

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER, 7 = PAMS/NAMS; 8 = PAMS/SLAMS) **% OBS** = PERCENTAGE OF VALID DAYS MONITORED DURING O3 SEASON **1ST, 2ND 1-HR MAX** = MAXIMUM 1-HR VALUE FOR THE 1ST & 2ND HIGHEST DAY **VALS > 0.125** = NUMBER OF MEASURED DAILY 1-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.125 PPM (1-HR STANDARD) **1ST, 2ND, 4TH 8-HR MAXIMA** = MAXIMUM 8-HR VALUE FOR THE 1ST, 2ND & 4TH HIGHEST DAY **VALS > 0.085** = NUMBER OF MEASURED DAILY 8-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.085 PPM (8-HR STANDARD)



2000 O3 Monitoring Network

Ozone (O_3) Summary, Continued

Maximum 1-hour O_3 Values

The figures below display the 1st and 2nd daily maximum 1–hour values at each site during 2000. The 1st and 2nd maximum values are for different days.

O3 Maximum Daily 1-hour Values

Standard = 0.125 ppm

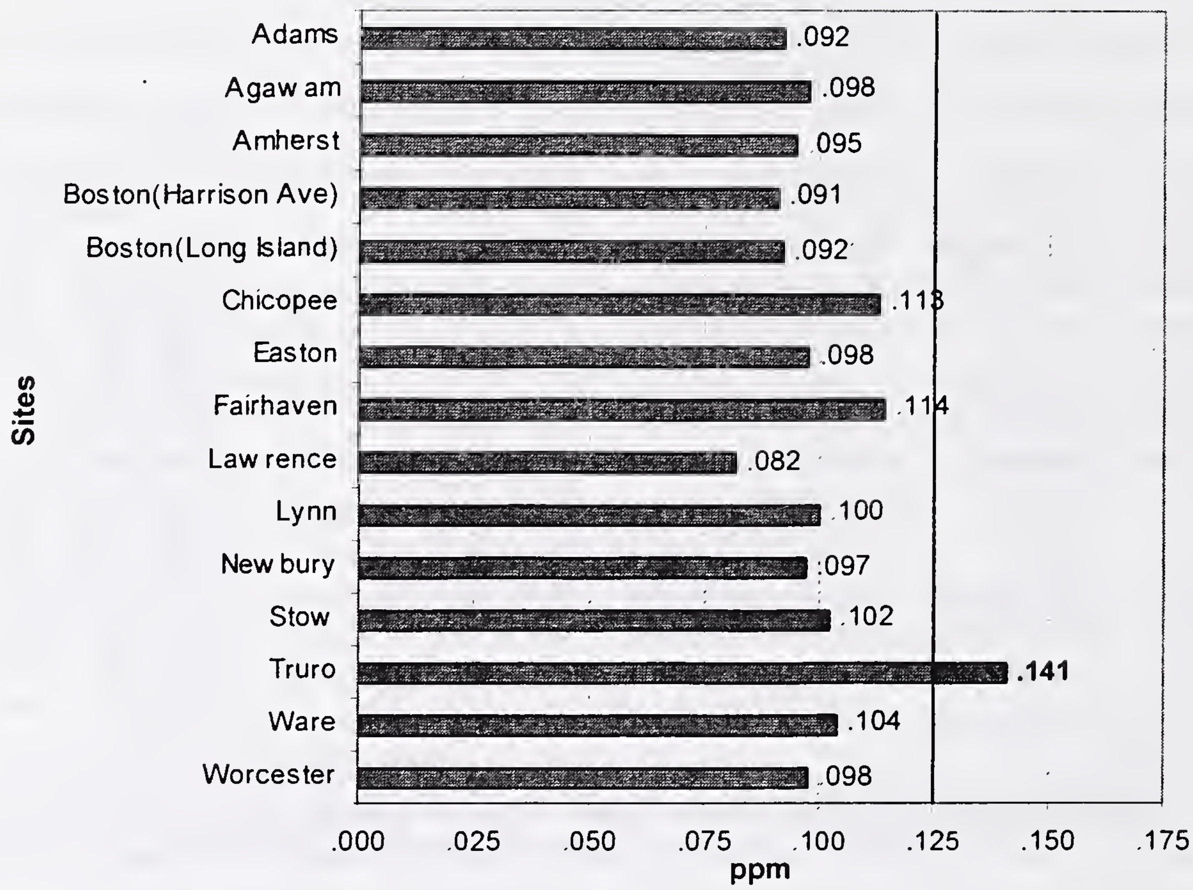


Figure 18

O3 2nd Maximum Daily 1-hour Values

Standard = 0.125 ppm

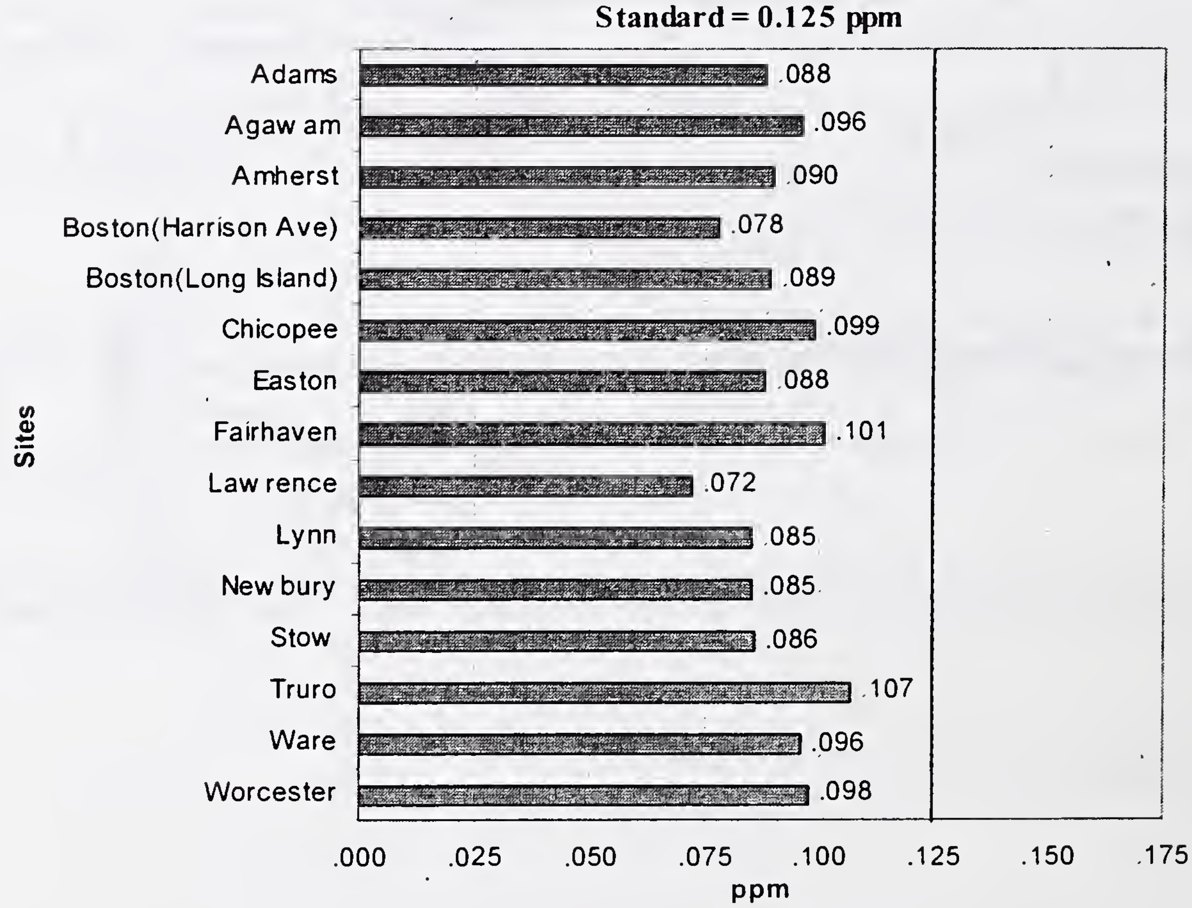


Figure 19

Maximum 8-hour O_3 values

The 1st and 4th maximum daily 8-hour O_3 values for 2000 are shown below. A 3-year average of the 4th maximum value is used to determine attainment status.

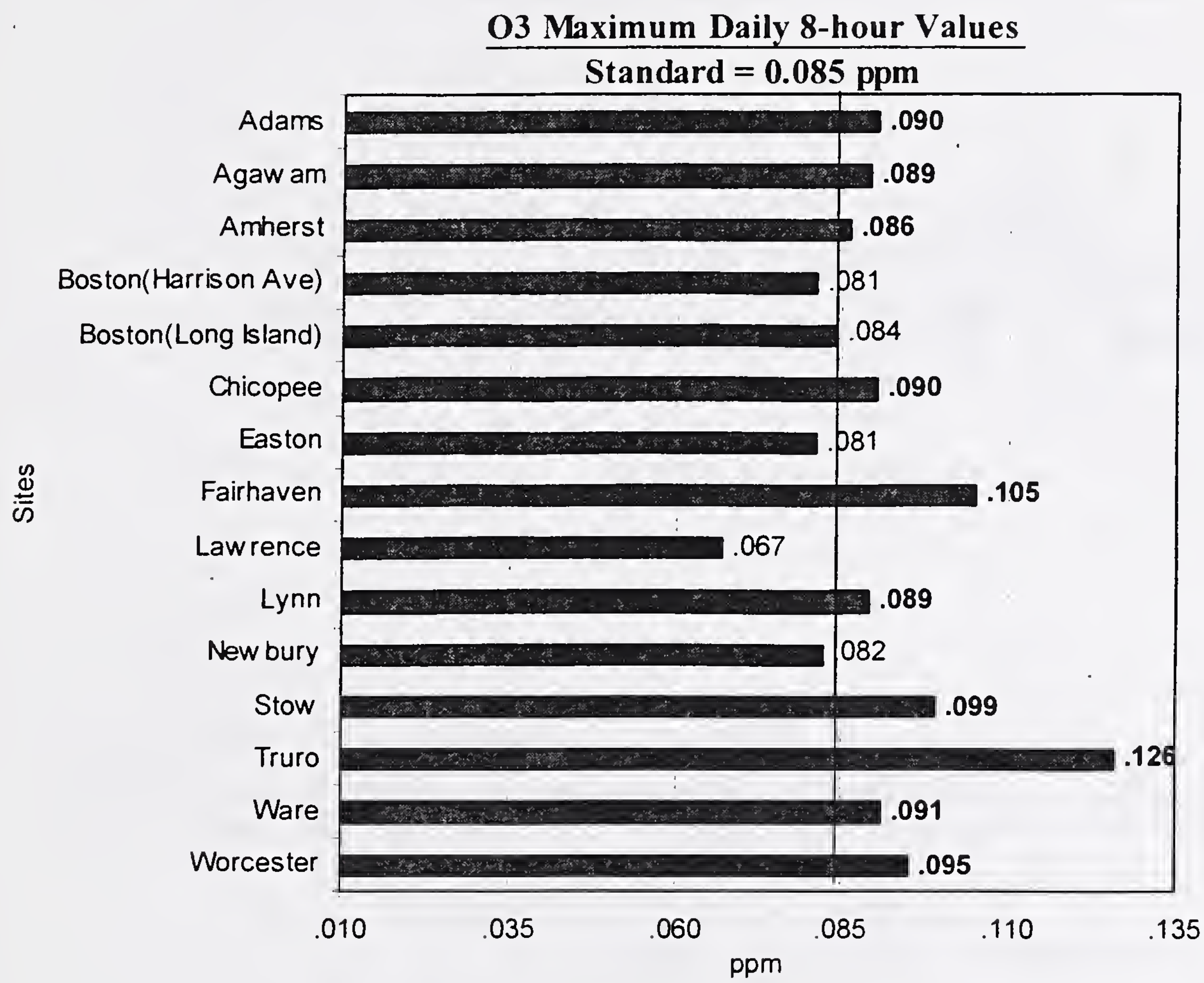


Figure 20

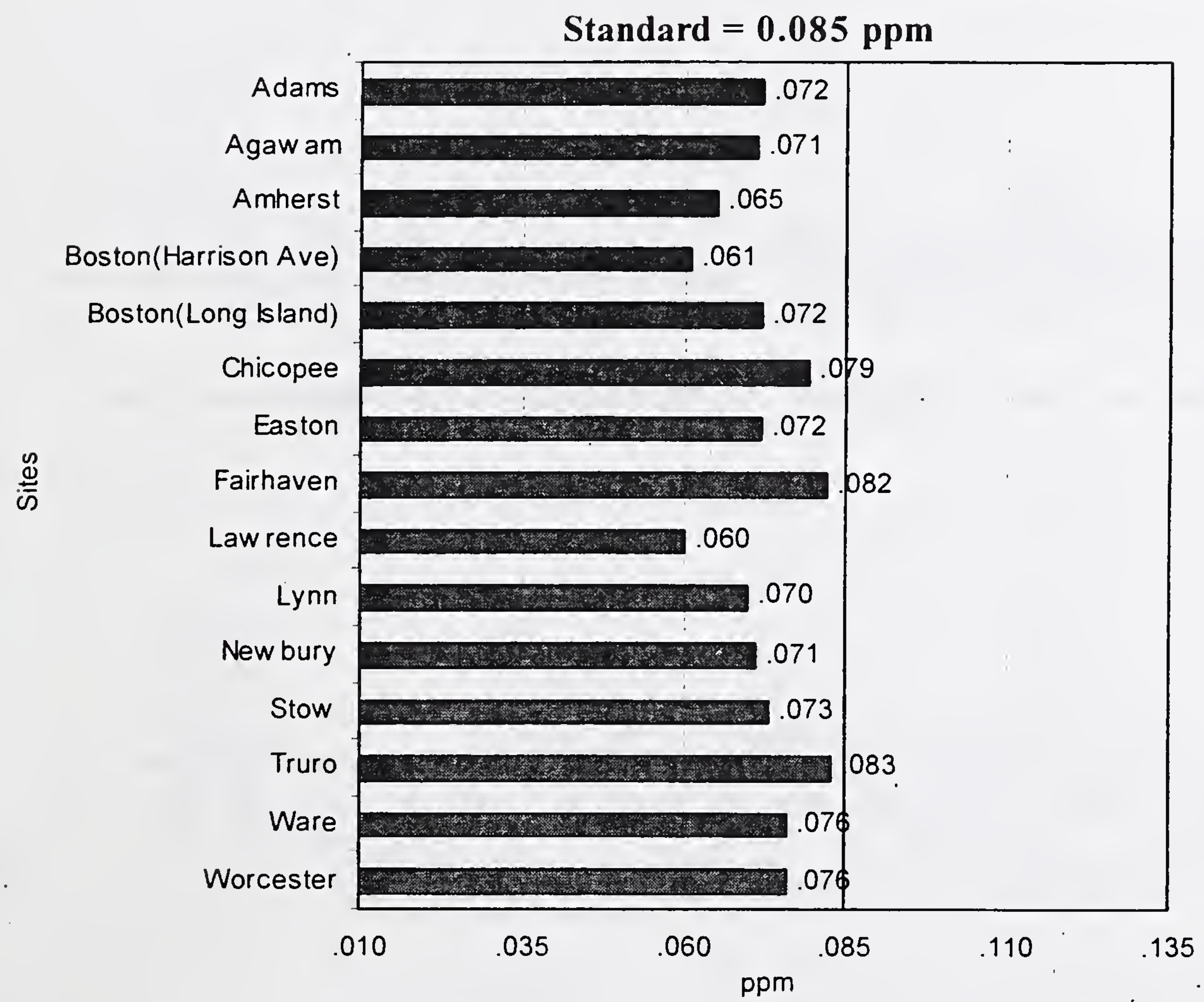


Figure 21

1-hour O_3 exceedance day trends

The long-term trends of 1-hour O_3 exceedance days for each site are shown below.

<u>O3 1-hour Exceedance Day Trends</u>

number of days O3 exceeded the standard (0.125)ppm)

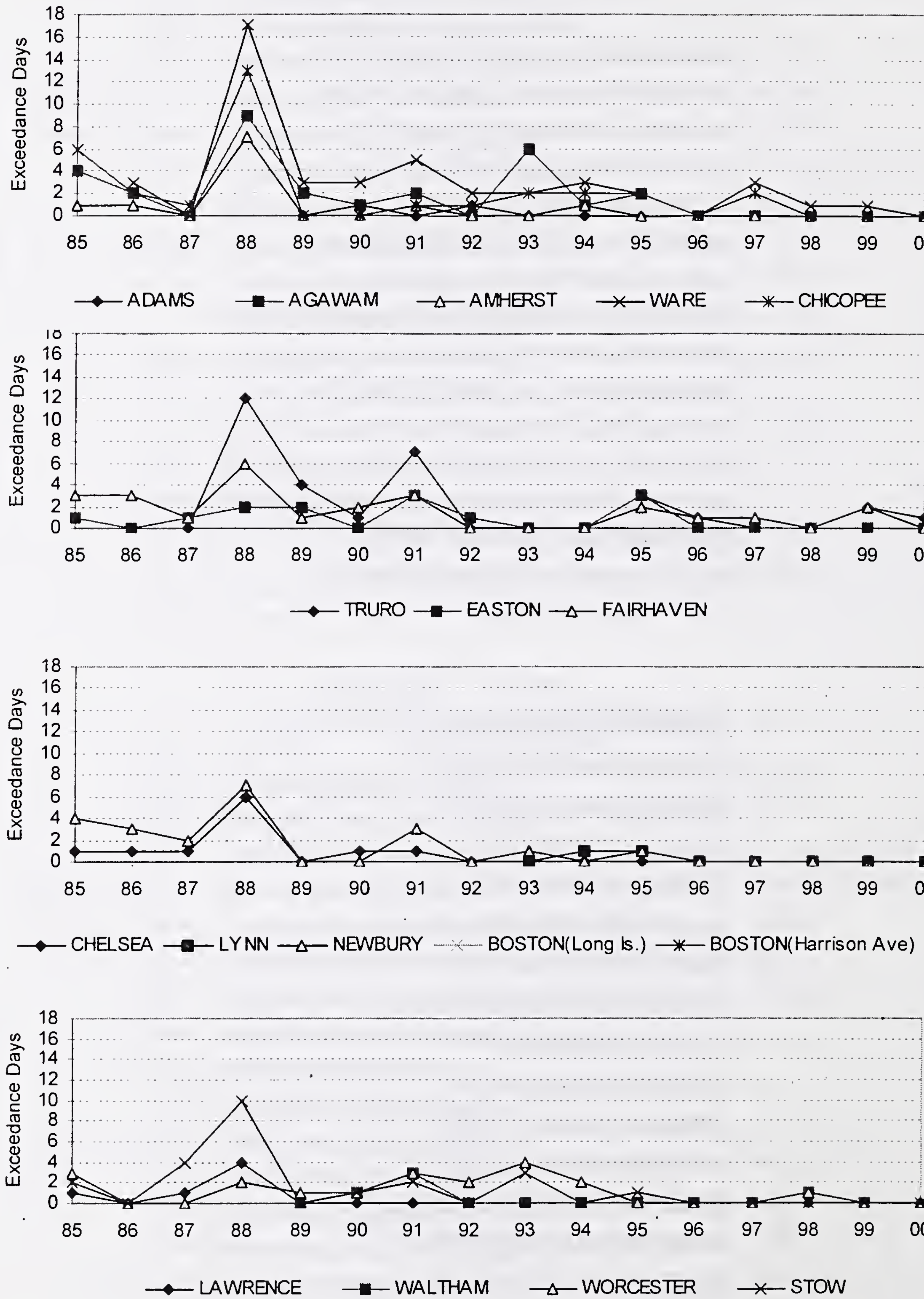


Figure 22

Ozone (O_3) Summary, Continued

8-hour O_3 exceedance day trends

The long-term trends of 8-hour O_3 exceedance days for each site are shown below.

<u>O3 8-hour Exceedance Day Trends</u>
Number of days O3 exceeded the standard (0.085)

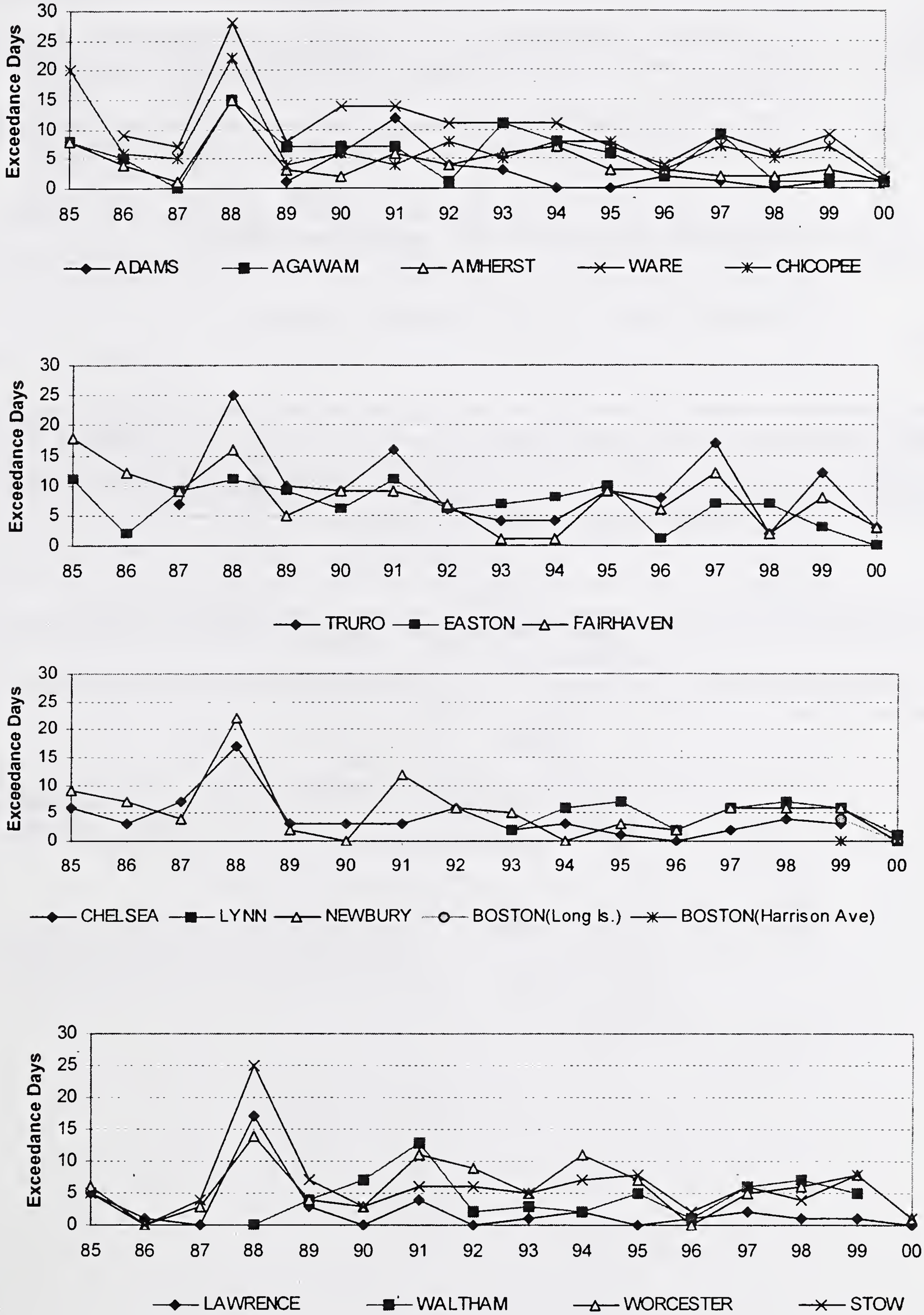


Figure 23

Sulfur Dioxide (SO_2) Summary

Introduction

There were 8 SO_2 sites during 2000 in the state-operated monitoring network. The Boston (Harrison Ave, Roxbury) site was opened in May.

SO_2 health effects and sources

- SO_2 combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis.
- SO_2 is a primary contributor to acid deposition. Impacts of acid deposition include acidification of lakes and streams, damage to vegetation, damage to materials,
- SO_2 is a product of fuel combustion (e.g., burning coal and oil). Sources include heat and power generation facilities and petroleum refineries.

The SO_2 standard

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
SO_2	Annual Arithmetic Mean	0.03 ppm (80 ug/m³)	None
	24-Hour	0.14 ppm (365 ug/m³)	None
	3-Hour	None	0.50 ppm (1300 ug/m³)

µg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

* Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

Continued on next page

2000 SO_2 data summary

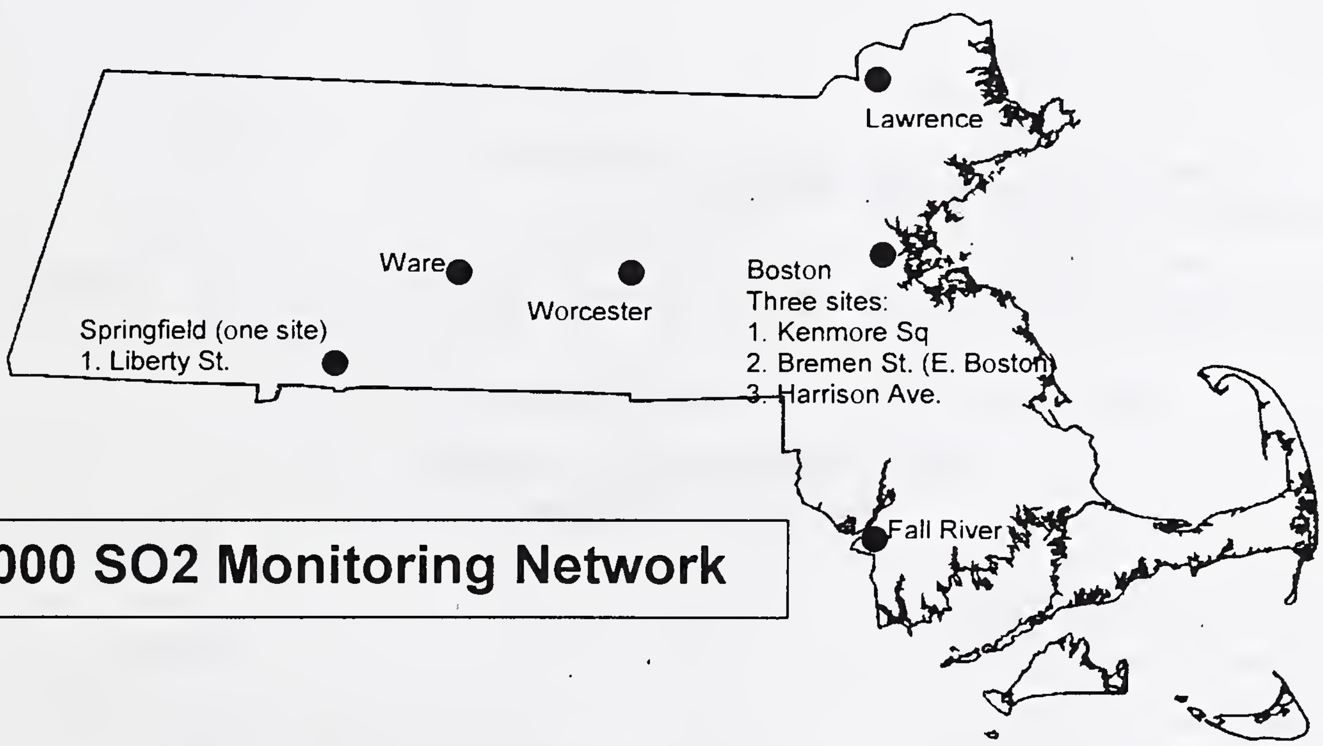
A summary of the 2000 data is listed below. All of the sites achieved the requirement of 75% or greater data capture for the year.

SITE ID	P O C	M T	CITY	COUNTY	ADDRESS (UNITS:PPM)	% OBS	MAX 24-HR 1ST	MAX 24-HR 2ND	MAX 3-HR 1ST	MAX 3-HR 2ND	MAX 1-HR 1ST	MAX 1-HR 2ND	ANN ARITH MEAN
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQUARE	97	.033	.029	.050	.050	.059	.055	.006
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMEN ST.	92	.022	.017	.045	.044	.054	.052	.004
25-025-0042	1	1	BOSTON	SUFFOLK	HARRISON AVENUE	98	.027	.023	.041	.037	.071	.058	.007?
25-005-1004	1	1	FALL RIVER	BRISTOL	GLOBE STREET	97	.055	.042	.096	.094	.146	.126	.005
25-009-0005	1	1	LAWRENCE	ESSEX	HIGH STREET	95	.020	.020	.057	.047	.070	.066	.004
25-013-0016	1	1	SPRINGFIELD	HAMPDEN	LIBERTY STREET	98	.025	.023	.060	.044	.081	.060	.005
25-015-4002	1	2	WARE	HAMPSHIRE	QUABBIN SUMMIT	94	.015	.015	.022	.022	.031	.024	.002
25-027-0020	1	1	WORCESTER	WORCESTER	CENTRAL STREET	98	.019	.019	.031	.031	.040	.038	.006

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)
TO CONVERT UNITS FROM PPM TO uG/M³ at standard conditions (25 celsius, 760 mmhg) MULTIPLY PPM x 2620

Standards: Annual Mean = 0.03 ppm 24-hour = 0.14 ppm 3-hour = 0.50 ppm

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG GREATER THAN 0.14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG. GREATER THAN 0.50 PPM (3-HR STANDARD) ANN **ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 0.03 PPM)



2000 SO2 Monitoring Network

Summary of SO_2 Values

The figures below present the 2000 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value that the 3-hour and 24-hour standards apply to. The highest 24-hour and 3- hour values occurred in Fall River, and the highest annual mean occurred at the Boston and Chelsea sites. All of the values were well within the air quality standards.

SO2 2nd Maximum 24-hour Values
Standard = 0.14 ppm

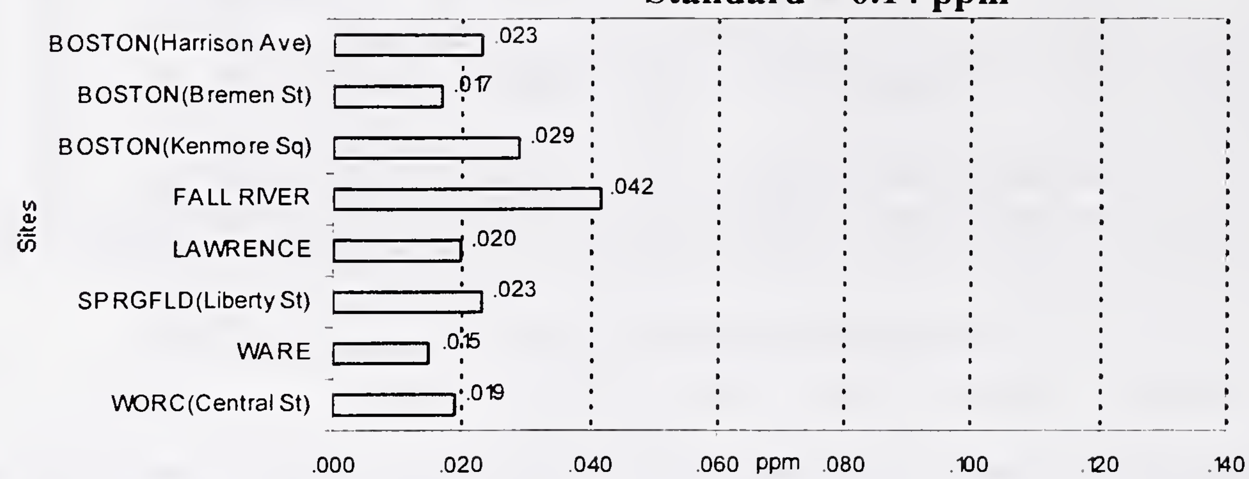


Figure 24

SO2 2nd Maximum 3-hour Values
Standard = 0.50 ppm

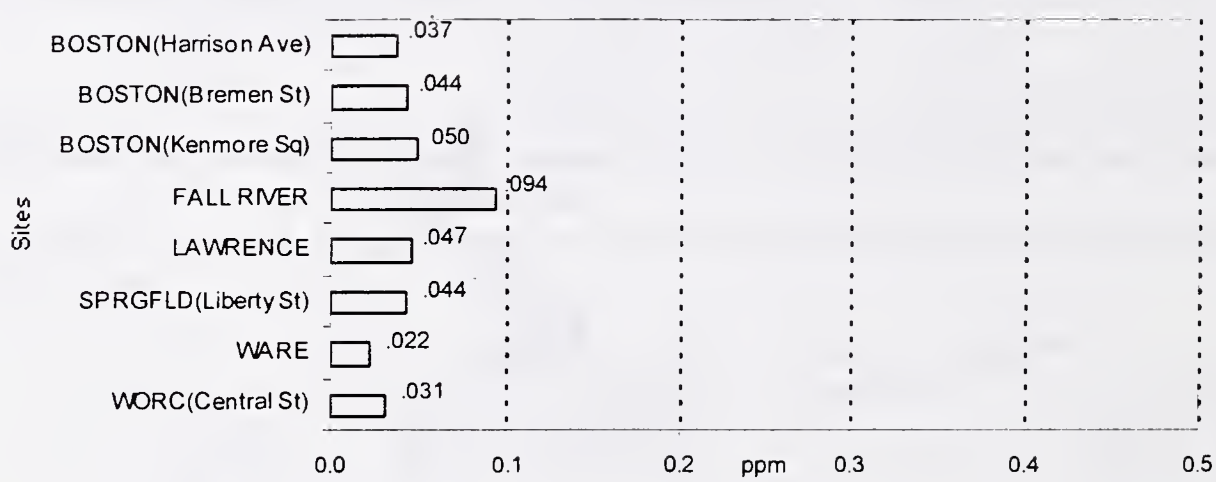


Figure 25

SO2 Annual Arithmetic Means
Standard = 0.03 ppm

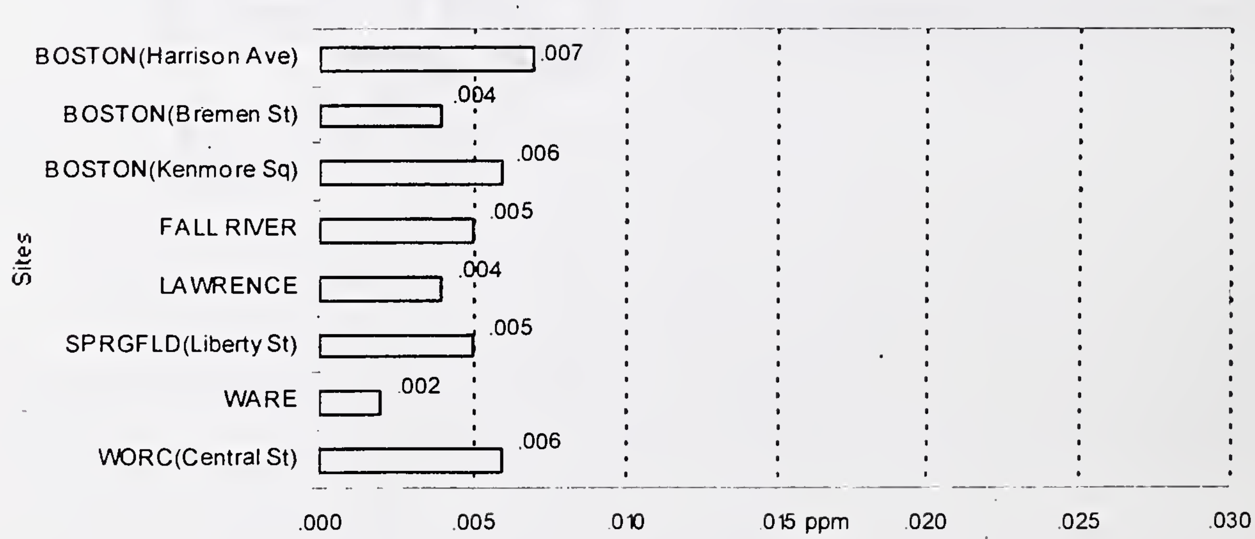
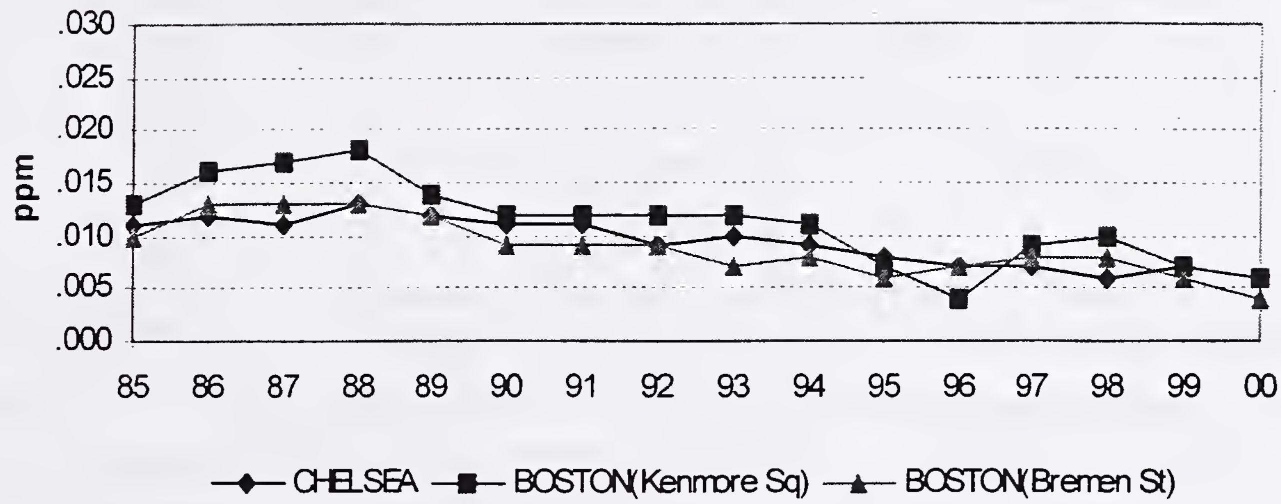


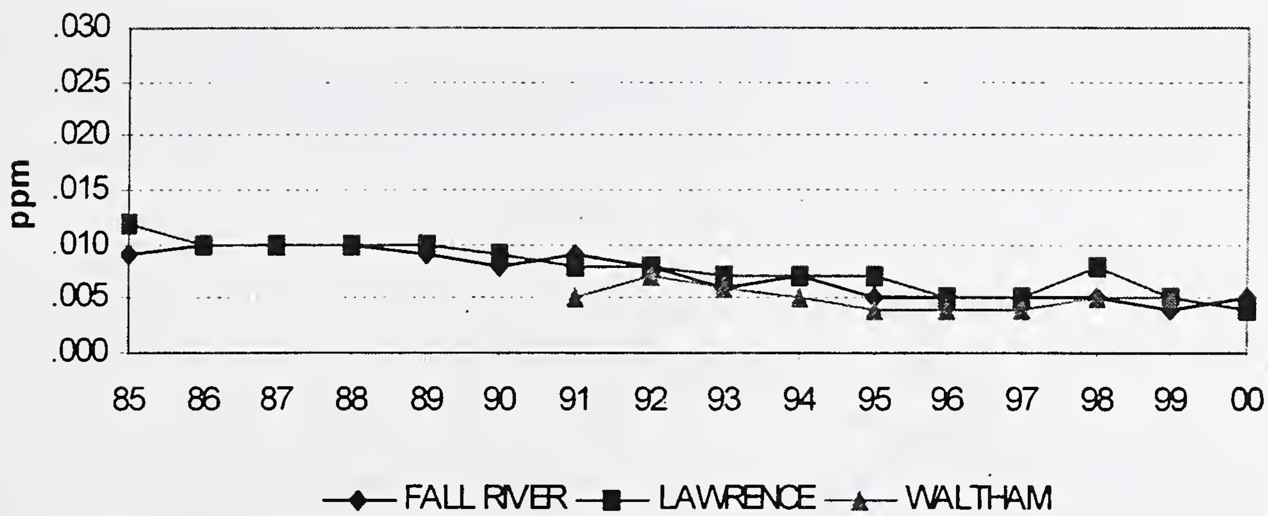
Figure 26

SO_2 trends

The long-term trends of the annual arithmetic mean for each SO_2 site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is well below the standard.

SO2 Trends 1985-2000
Annual Arithmetic Means
Standard = 0.03 ppm





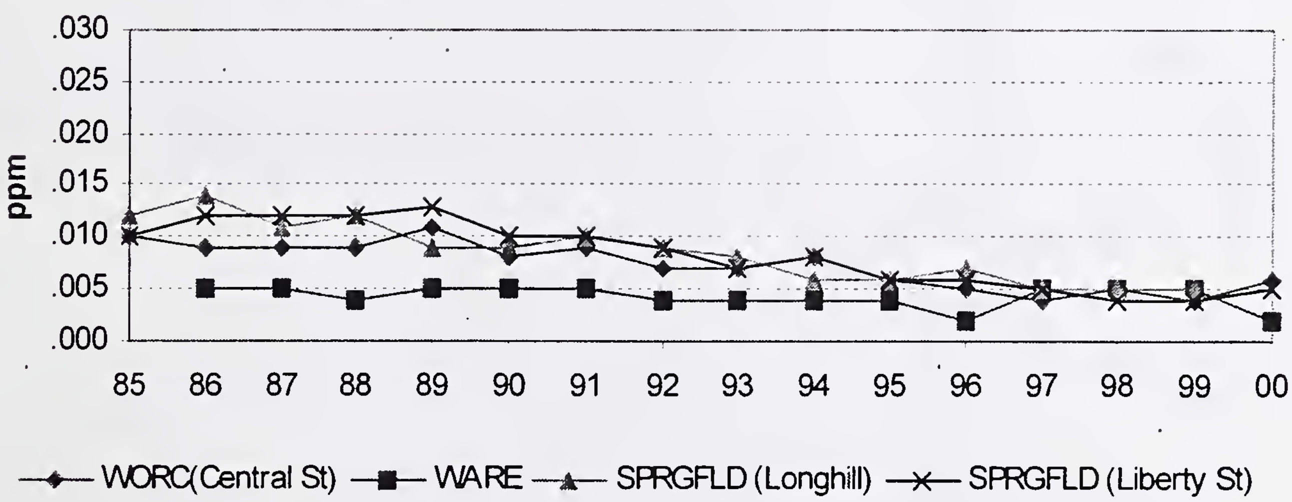


Figure 27

Nitrogen Dioxide (NO_2) Summary

Introduction	There were 13 NO_2 sites during 2000 in the state-operated monitoring network.
NO_2 health effects and sources	• NO_2 lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis. • NO_2 contributes to acid deposition. [See SO_2 listing above for the effects.] • NO_2 and NO contribute to the formation of ozone. • NO_2 is formed from the oxidation of nitric oxide (NO). Major sources of NO are fuel combustion, heating and power plants, and motor vehicles.
The NO_2 standard	The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
NO_2	Annual Arithmetic Mean	0.053 ppm 100 ug/m³	Same as Primary Standard

µg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

Continued on next page

Nitrogen Dioxide (NO2) Summary, Continued

2000 NO_2 data summary

All sites met the requirement of 75% data capture for the year.

A summary of the 2000 data is listed below.

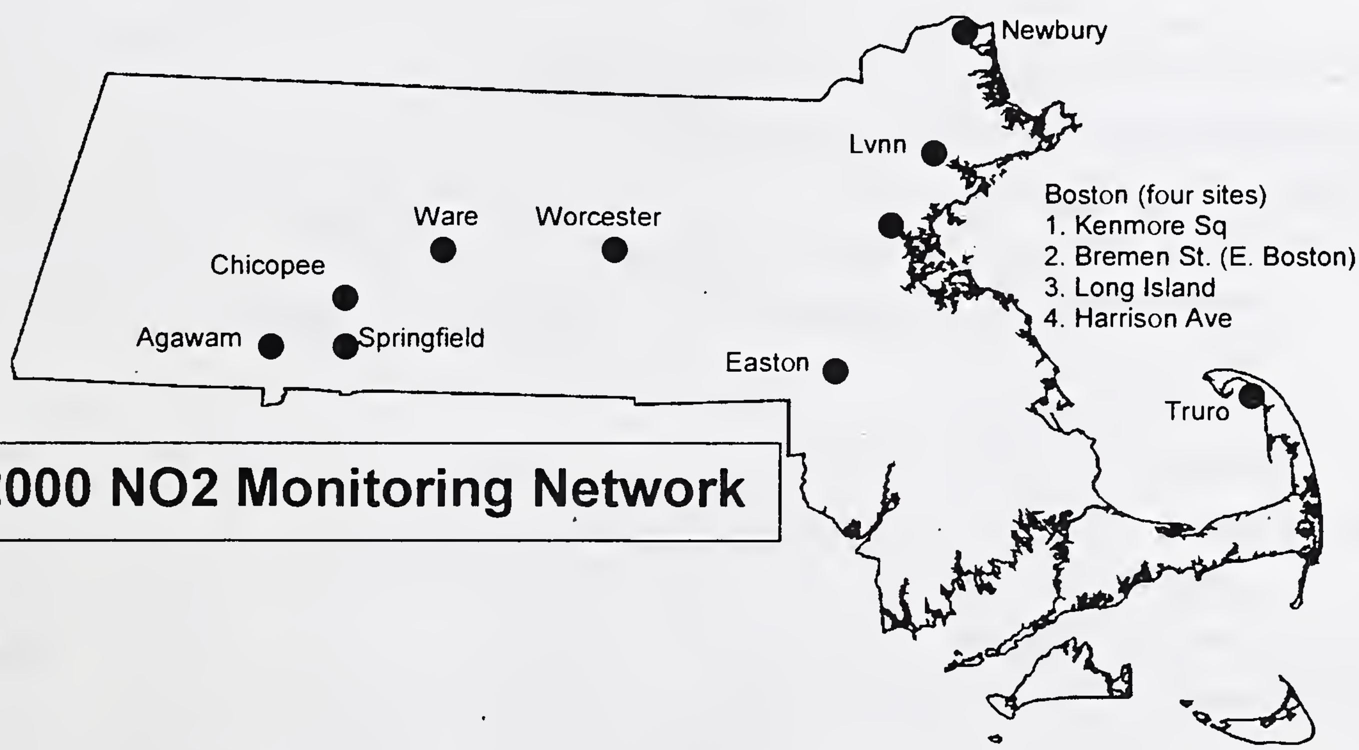
SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS: PPM)	% OBS	MAX 1-HR 1ST	MAX 1-HR 2ND	ARITH MEAN
25-013-0003	1	8	AGAWAM	HAMPDEN	152 SOUTH WESTFIELD STREET	96	.051	.048	.009?
25-025-0002	1	3	BOSTON	SUFFOLK	KENMORE SQUARE	86	.086	.085	.029
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMEN STREET, EAST BOSTON	86	.083	.079	.022
25-025-0041	1	8	BOSTON	SUFFOLK	LONG ISLAND HOSPITAL ROAD	82	.069	.068	.011?
25-025-0042	1	1	BOSTON	SUFFOLK	HARRISON AVE	78	.062	.058	.024?
25-013-0008	1	8	CHICOPEE	HAMPDEN	ANDERSON ROAD AIR FORCE BASE	93	.062	.061	.013?
25-005-1005	1	8	EASTON	BRISTOL	1 BORDERLAND ST.	80	.050	.049	.007?
25-009-2006	1	8	LYNN	ESSEX	390 PARKLAND AVE.	77	.057	.056	.011?
25-009-4004	1	8	NEWBURY	ESSEX	SUNSET BOULEVARD	96	.043	.038	.006?
25-013-0016	1	2	SPRINGFIELD	HAMPDEN	LIBERTY STREET PARKING LOT	95	.101	.100	.026
25-001-0002	1	8	TRURO	BARNSTABLE	FOX BOTTOM AREA-CAPE COD	96	.037	.030	.003?
25-015-4002	1	8	WARE	HAMPSHIRE	QUABBIN SUMMIT	85	.053	.052	.006
25-027-0020	1	2	WORCESTER	WORCESTER	CENTRAL STREET FIRE STATION	89	.074	.063	.018

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

TO CONVERT UNITS FROM PPM TO uG/M³ at standard conditions (25 celsius, 760 mmhg) MULTIPLY PPM x 1880

Standard: Annual Arithmetic Mean = 0.053

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER, 7 = PAMS/NAMS, 8 = PAMS/SLAMS) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARITH MEAN** = ANNUAL ARITHMETIC MEAN



2000 NO2 Monitoring Network

Nitrogen Dioxide (NO_2) Summary, Continued

NO_2 data summary

The figures below present the 2000 data relative to the air quality standard. There is no 1-hour NO_2 ambient air quality standard, but there is one for the annual arithmetic mean. The highest mean occurred in Boston and was well below the standard.

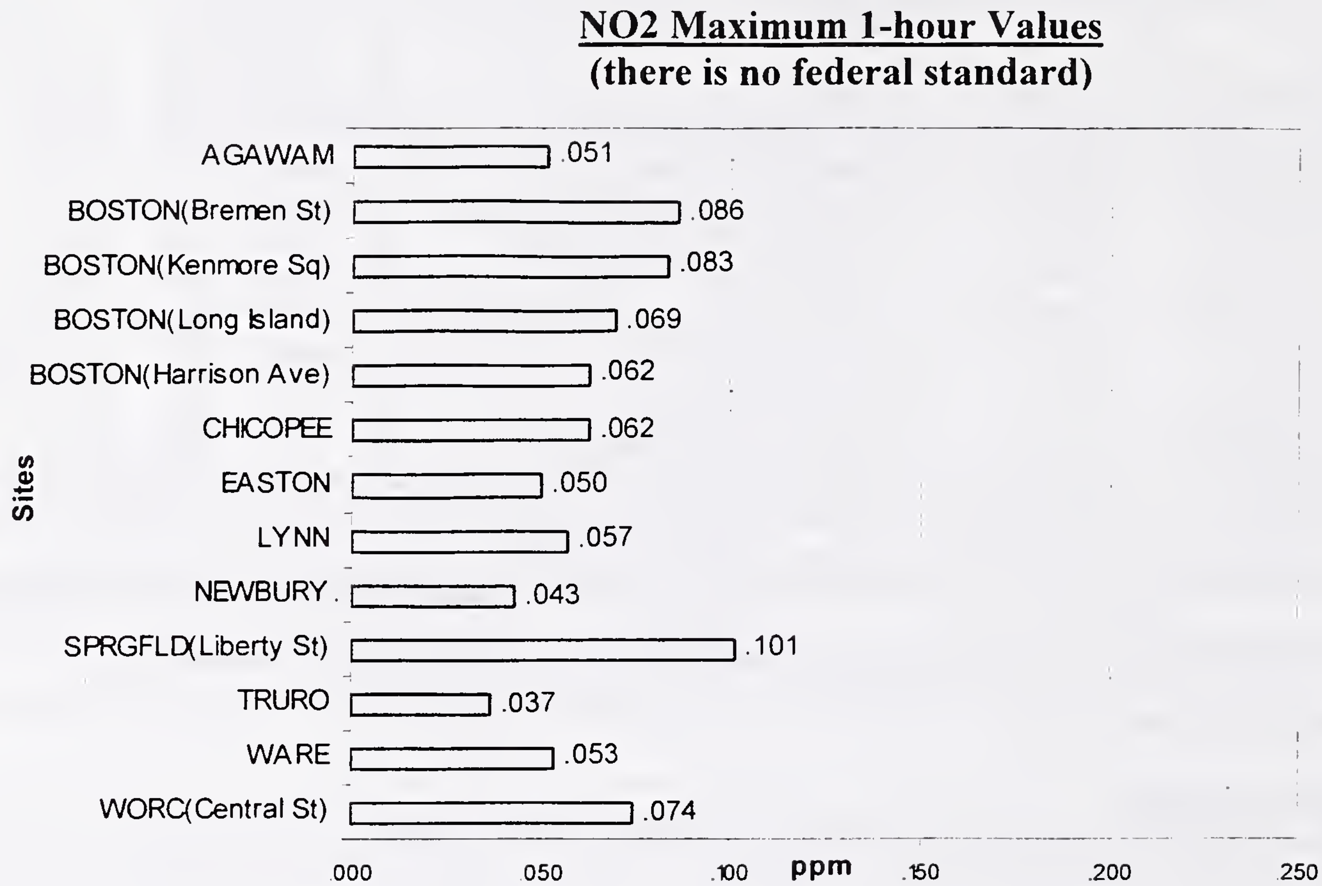


Figure 28

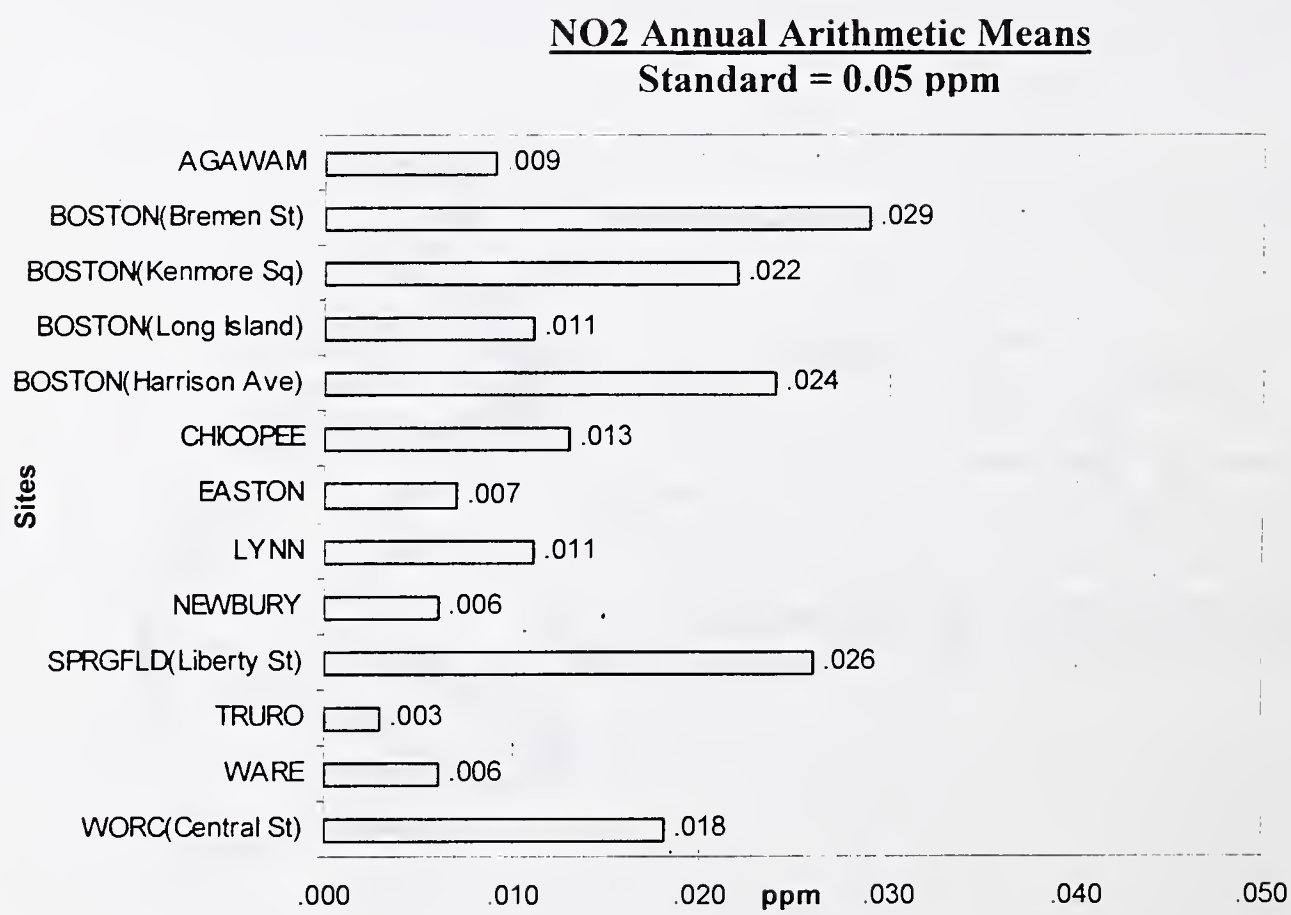


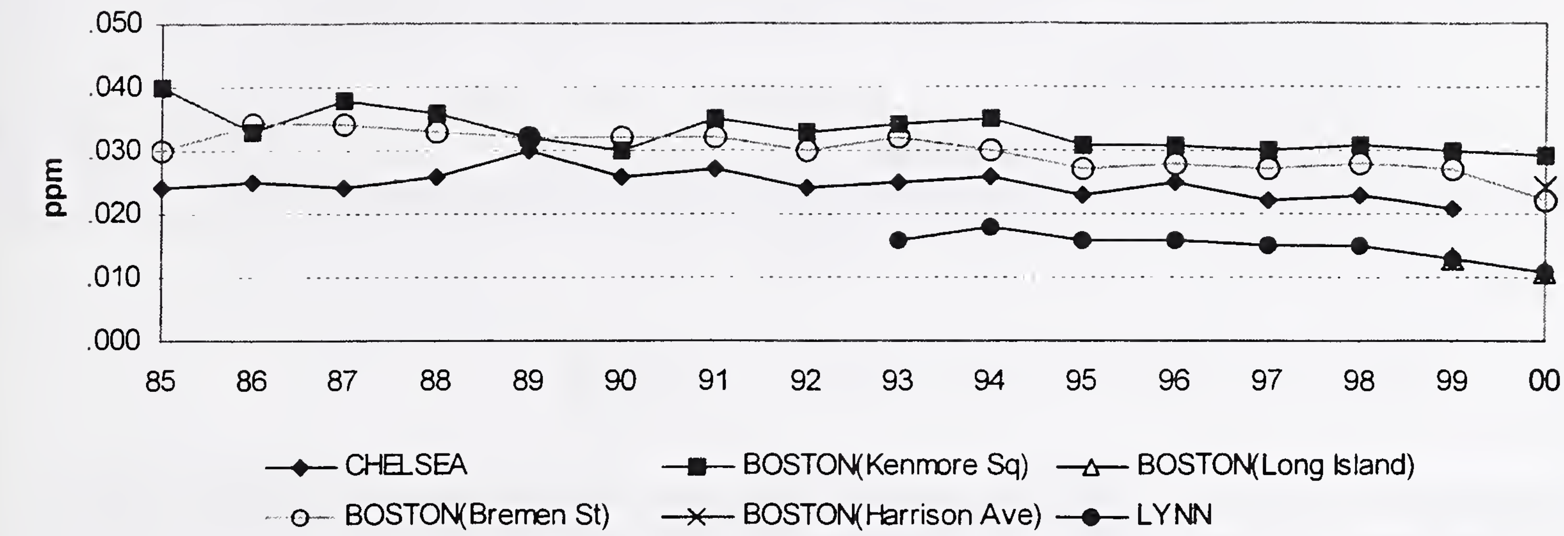
Figure 29

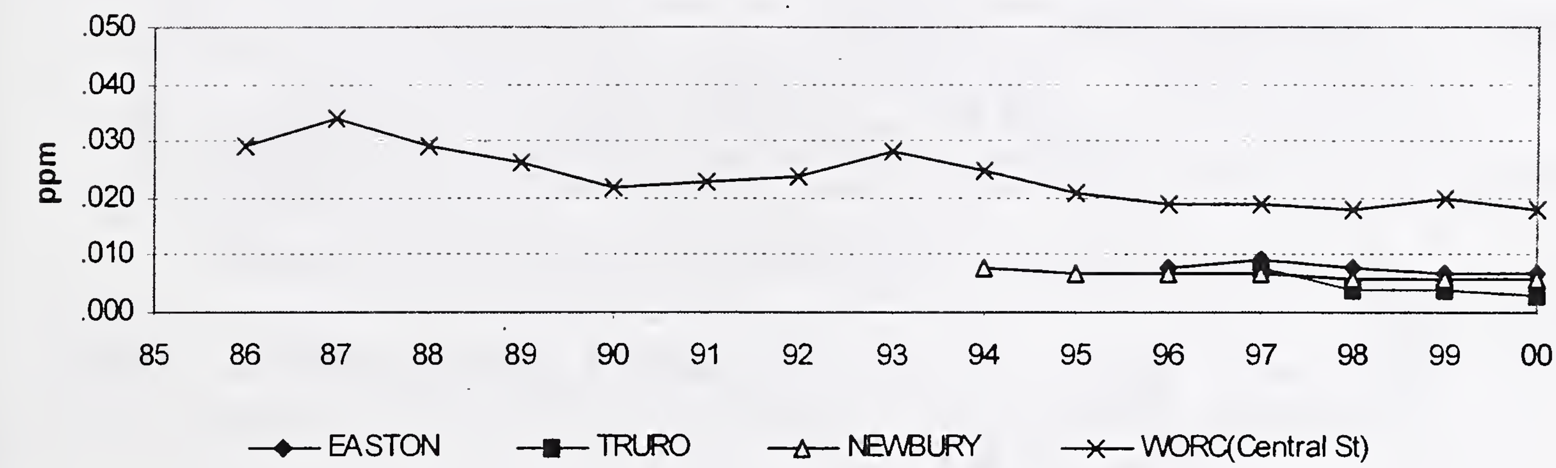
Nitrogen Dioxide (NO_2) Summary, Continued

NO_2 trends

The long-term trends of the annual arithmetic means for each NO_2 site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is below the standard.

<u>NO2 Trends 1985-2000</u>
Annual Arithmetic Means
Standard = 0.05 ppm





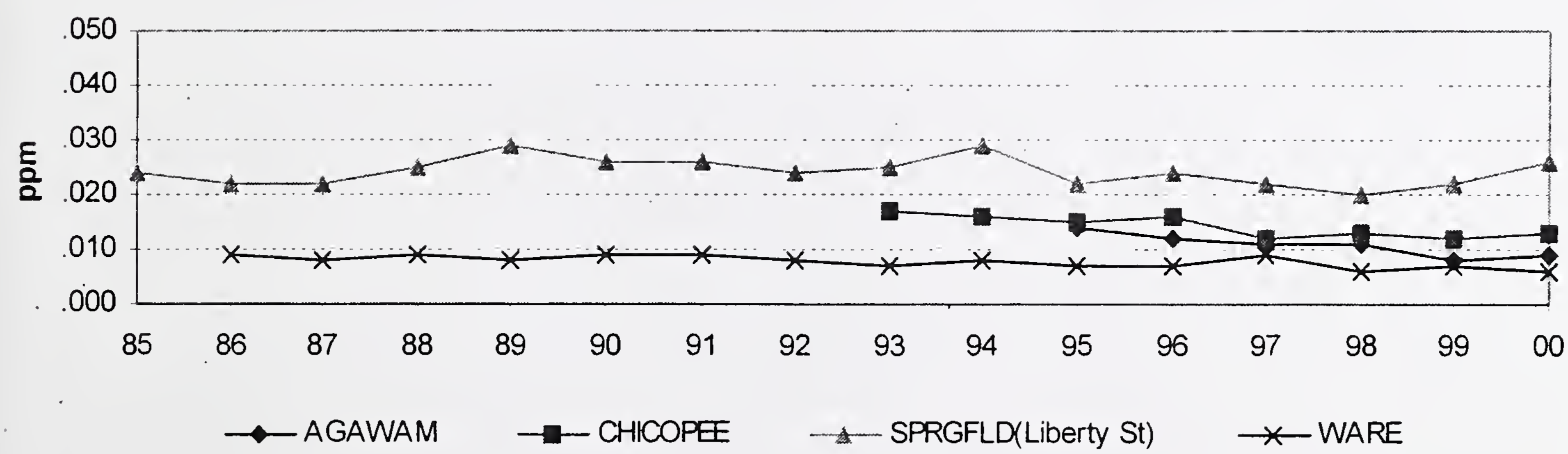


Figure 30

Carbon Monoxide (CO) Summary

Introduction

There were eight CO sites during 2000 in the state-operated monitoring network.

CO health effects and sources

- CO reacts in the bloodstream with hemoglobin, reducing oxygen carried to organs and tissues.
- Symptoms of high CO exposure include shortness of breath, chest pain, headaches, confusion, and loss of coordination. The health threat is most severe for those with cardiovascular disease.
- High levels of CO are possible near parking lots and city streets with slow-moving cars, particularly during peak traffic times.
- Motor vehicle emissions are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.

The CO standard

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
CO	8-Hour	9 ppm (10 mg/m^3)	Same as Primary Standard
	1-Hour	35 ppm (40 mg/m^3)	Same as Primary Standard

$\mu g/m^3$ = micrograms per cubic meter **ppm** = parts per million **mg/m^3** = milligrams per cubic meter

* Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

Continued on next page

Carbon Monoxide (CO) Summary, Continued

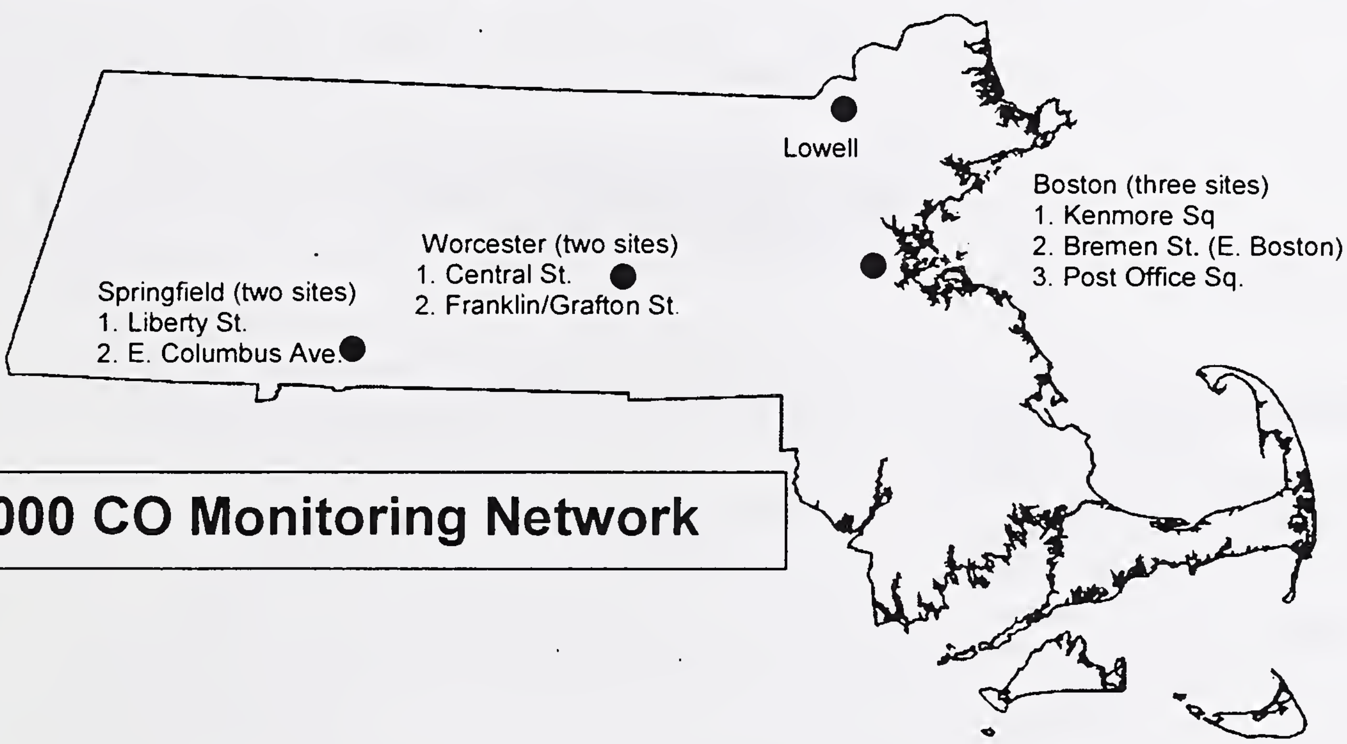
2000 CO data summary

All of the sites achieved the requirement of 75% or greater data capture for the year. A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAX 1-HR 1ST	MAX 1-HR 2ND	OBS ≥ 35	MAX 8-HR 1ST	MAX 8-HR 2ND	OBS > 9
					UNITS: PPM							
25-025-0002	1	2	BOSTON	SUFFOLK	KENMORE SQ., 590 COMM. AVE	86	3.6	3.4	0	3.0	2.3	0
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMEN ST., E. BOSTON	92	3.5	3.0	0	2.4	2.4	0
25-025-0038	1	1	BOSTON	SUFFOLK	FEDERAL POST OFFICE BLDG	90	3.0	2.9	0	2.2	2.1	0
25-017-0007	1	2	LOWELL	MIDDLESEX	OLD CITY HALL, MERRIMACK ST	94	6.0	5.3	0	3.5	3.2	0
25-013-0016	1	1	SPRINGFIELD	HAMPDEN	LIBERTY STREET PARKING LOT	94	5.1	5.1	0	4.4	4.0	0
25-013-2007	1	1	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVENUE	93	6.5	5.4	0	4.0	3.6	0
25-027-0020	1	2	WORCESTER	WORCESTER	CENTRAL STREET FIRE STATION	91	4.8	4.4	0	2.8	2.6	0
25-027-0022	1	2	WORCESTER	WORCESTER	FRANKLIN/GRAFTON STREETS	91	9.5	9.0	0	6.1	3.3	0

Standards: 1-hour = 35 ppm 8-hour = 9 ppm

ABBREVIATIONS AND SYMBOLS USED IN TABLE 15
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > 35** = NUMBER OF 1-HR AVG GREATER THAN 35 PPM (1-HR STANDARD) **OBS > 9** = NUMBER OF 8-HR AVG. GREATER THAN 9 PPM (8-HR STD)



2000 CO Monitoring Network

CO data summary

The figures below present the 2000 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value to which the standards apply. The highest 1-hour value occurred in Worcester and the highest 8-hour value occurred in Springfield. Both were well within the standard.

CO 2nd Maximum 1-hour Values
Standard = 35 ppm

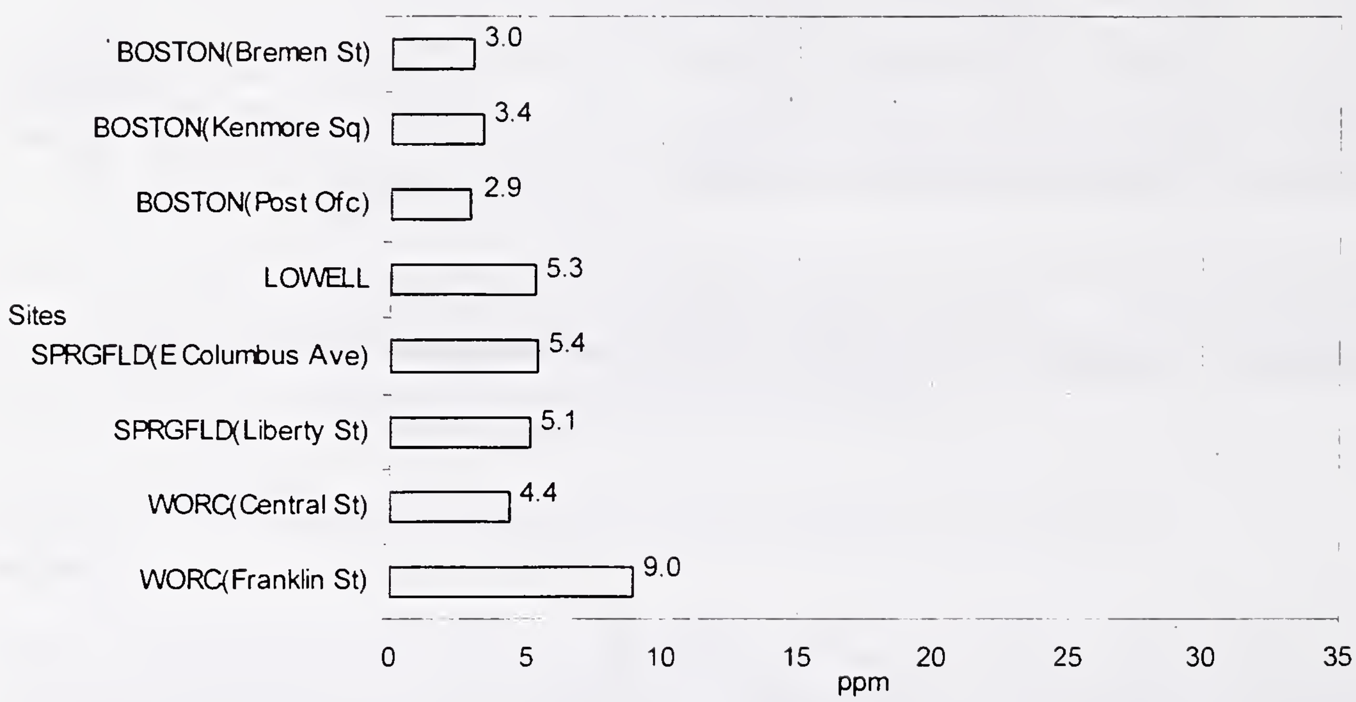


Figure 31

CO 2nd Maximum 8-hour Values
Standard = 9 ppm

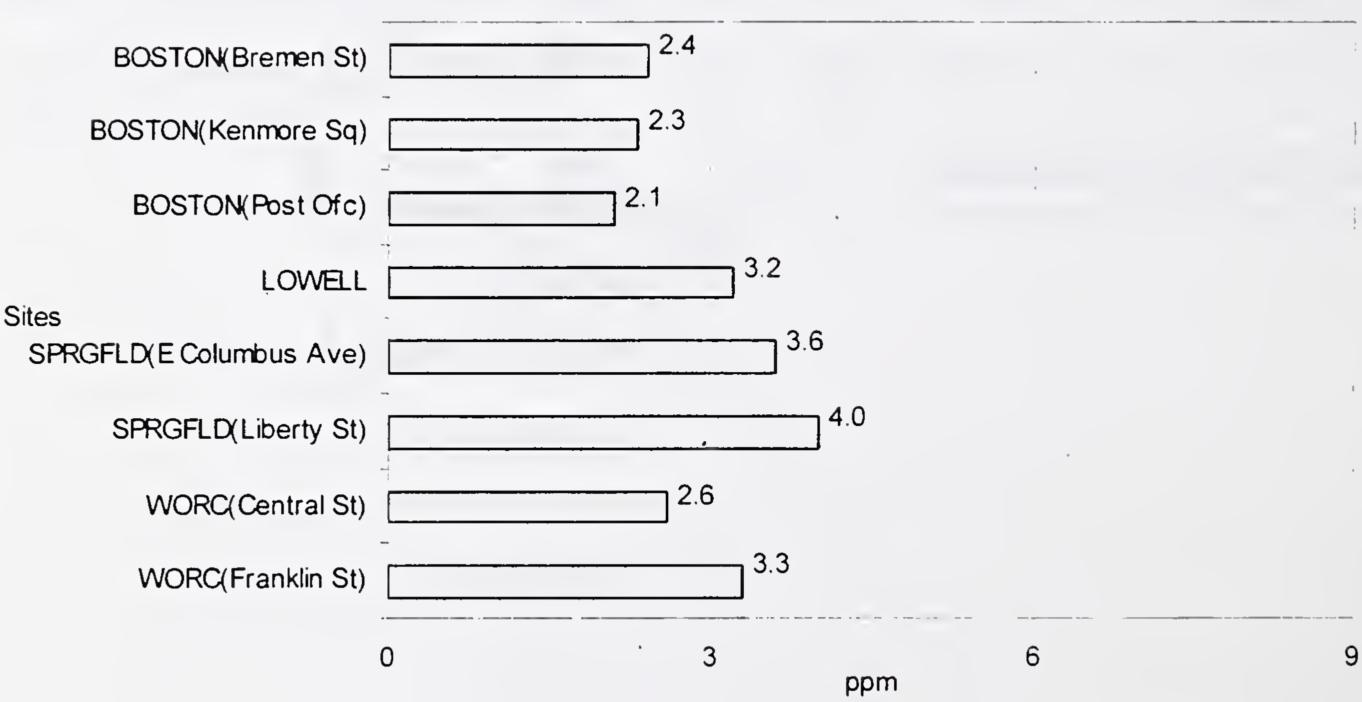
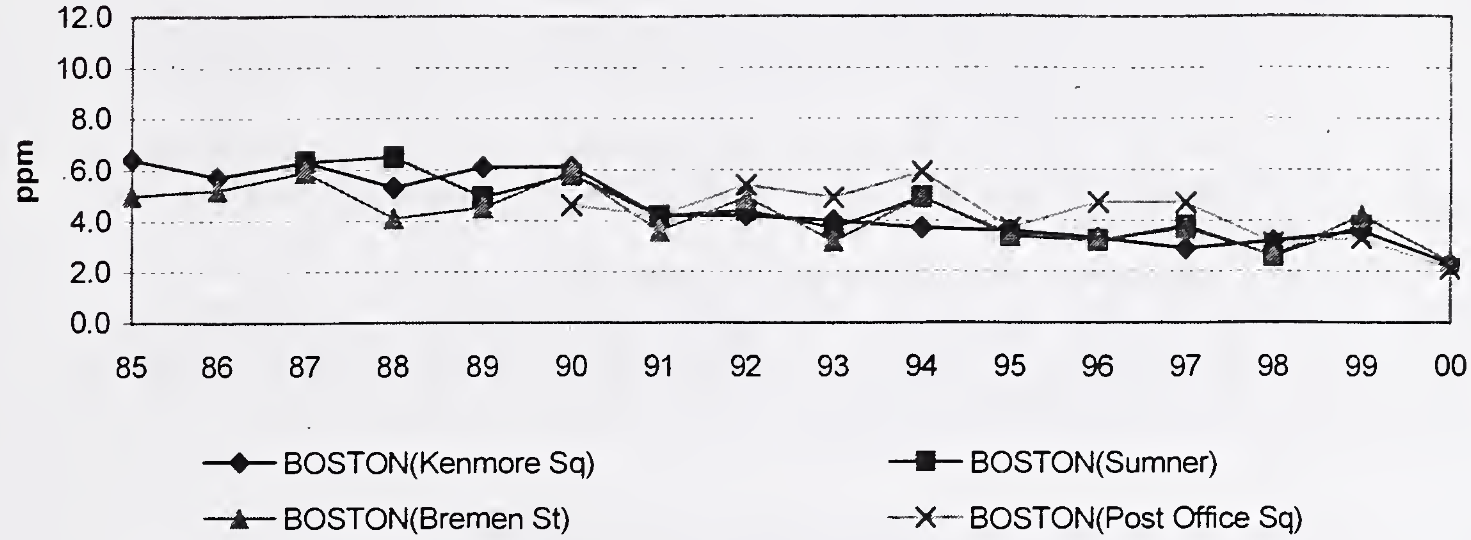
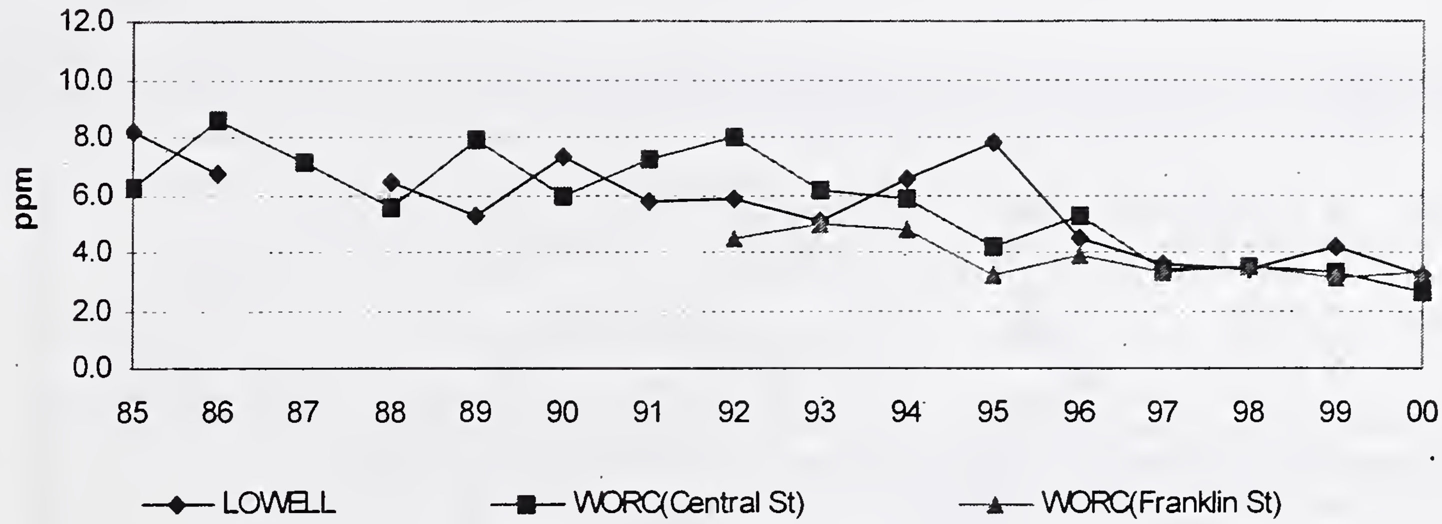


Figure 32

CO trends The long-term trends of the 2nd-maximum 8-hour value for each CO site are shown below. The data shows a yearly variability at most sites, with the overall trend being downward. Massachusetts is below the standard.

CO Trends 1985-2000
2nd Maximum 8-hour Values
Standard = 9 ppm





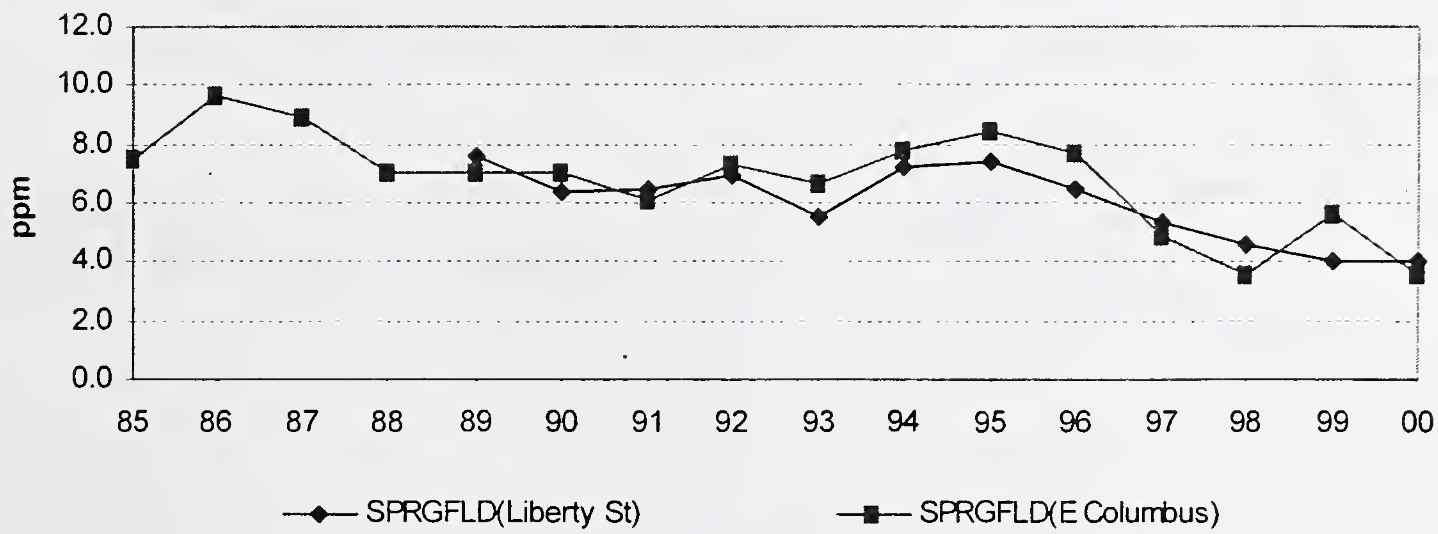


Figure 33

Particulate Matter 10-Microns (PM10) Summary

Introduction

There were eight PM_{10} sites (three sites had collocated monitors-two of the same sampler for precision purposes) during 2000 in the state-operated monitoring network. The network was trimmed from the 16 sites operated during 1998. Those areas that had sites closed are now represented in the $PM_{2.5}$ network.

Particulate matter information

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, soot, smoke, and liquid droplets.
- The numbers 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.
- The small size of the particles allows entry into the respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and respiratory symptoms.
- Particulate matter causes soiling and corrosion of materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, agriculture, and construction activities.

The PM_{10} standard

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
PM_{10} Particulates up to 10 microns in size	Annual Arithmetic Mean	50 ug/m³	Same as Primary Standard
	24-Hour	150 ug/m³	Same as Primary Standard

- The PM_{10} standard is based upon estimated exceedance calculations described in 40CFR Part 50, Appendix K.
- The annual standard is met if the estimated annual arithmetic mean does not exceed 50 ug/m^3.
- The 24-hour standard is attained if the estimated number of days per calendar year above 150 ug/m^3 does not exceed one per year.

µg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

* Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

Continued on next page

Particulate Matter 10-Microns (PM10) Summary, Continued

2000 PM_{10} data summary

Seven out of the eight sites achieved the requirement of 75% or greater data capture for each calendar quarter. Sampler failure caused Boston, Southampton St. not to achieve the data capture requirement.

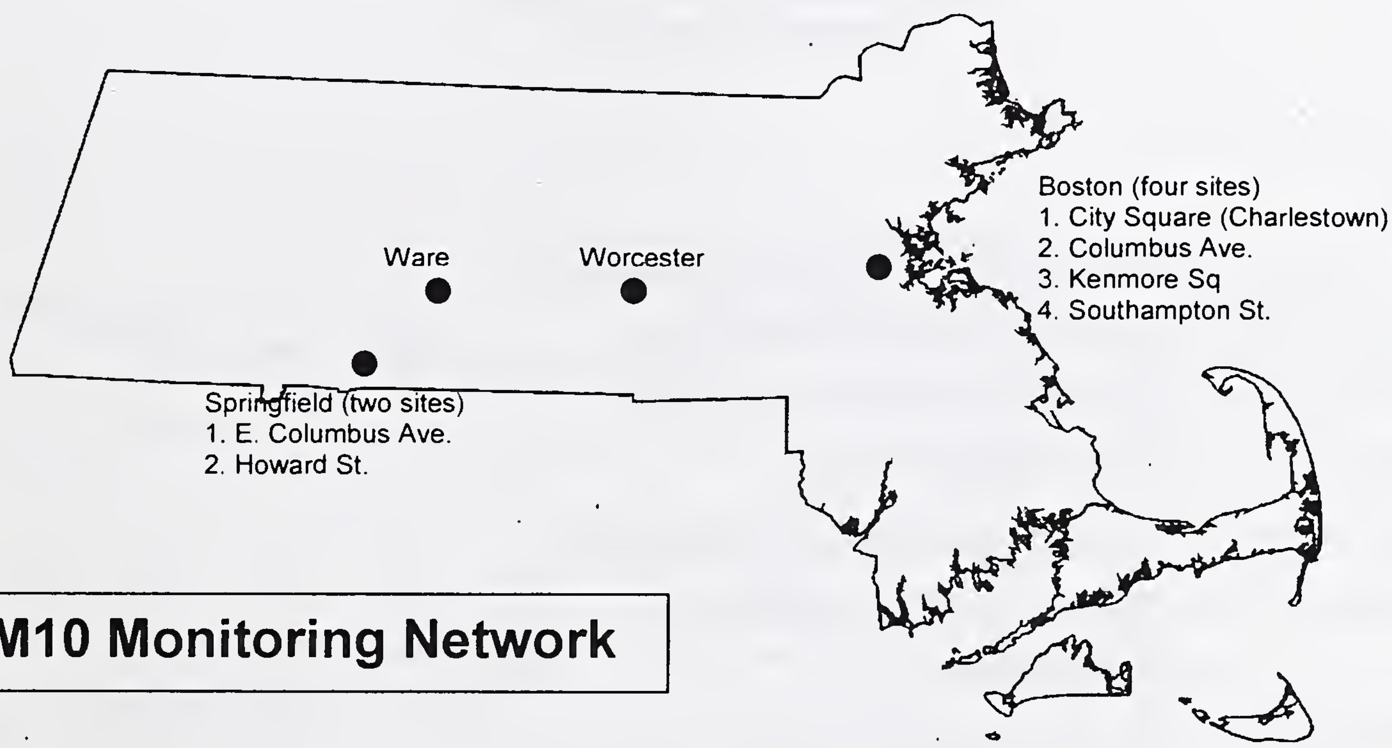
A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS: UG/CU METER)	% OBS	-MAX 24 HR–VALUE- 1ST	2ND	3RD	4TH	VALS MEAS	> 150 EST	WTD ARITH MEAN
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQUARE	89	73	53	47	46	0	0.00	25
25-025-0012	1	1	BOSTON	SUFFOLK	115 SOUTHAMPTON ST.	66	42	34	34	33	0	0.00	18?
25-025-0012	2	3	BOSTON	SUFFOLK	115 SOUTHAMPTON ST.	20	33	31	26	26	0	0.00	20?
25-025-0024	1	1	BOSTON	SUFFOLK	200 COLUMBUS AVE.	75	57	46	45	36	0	0.00	24?
25-025-0027	1	1	BOSTON	SUFFOLK	ONE CITY SQUARE	86	70	59	58	56	0	0.00	29
25-025-0027	3	3	BOSTON	SUFFOLK	ONE CITY SQUARE	78	63	59	56	55	0	0.00	29?
25-013-0011	2	2	SPRINGFIELD	HAMPDEN	59 HOWARD STREET	86	53	52	43	38	0	0.00	21
25-013-2007	1	1	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVE.	91	77	57	56	53	0	0.00	28
25-013-2007	3	3	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVE.	80	79	57	57	52	0	0.00	28?
25-015-4002	1	2	WARE	HAMPSHIRE	QUABBIN SUMMIT	91	54	25	22	22	0	0.00	11
25-027-0016	1	1	WORCESTER	WORCESTER	2 WASHINGTON ST.	89	80	54	45	41	0	0.00	19

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

Standards: 24-hour = 150 μg/m³   Annual Arithmetic Mean = 50 μg/m³

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUE 1ST, 2ND, 3RD, 4TH** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **VALS > 150 MEAS** = NUMBER OF VALUES GREATER THAN 150 μg/m³ (PM-10 STANDARD) **VALS > 150 EST** = NUMBER OF EXPECTED VIOLATIONS **WTD ARITH MEAN** = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 50 μg/m³) ? = INDICATES THAT NUMBER OF OBSERVATIONS WERE INSUFFICIENT TO CALCULATE MEAN THE DATA CAPTURE AT A SITE MUST EXCEED 75% FOR EACH QUARTER



2000 PM10 Monitoring Network

Particulate Matter 10-Microns (PM_{10}) Summary, Continued

PM_{10} data summary

The figures below present the 2000 data relative to the air quality standards. The highest 24-hour and annual arithmetic mean values each occurred in Boston, City Square. Both were well within the standards.

PM10 2nd Maximum 24-hour Values
Standard – 150 ug/m3

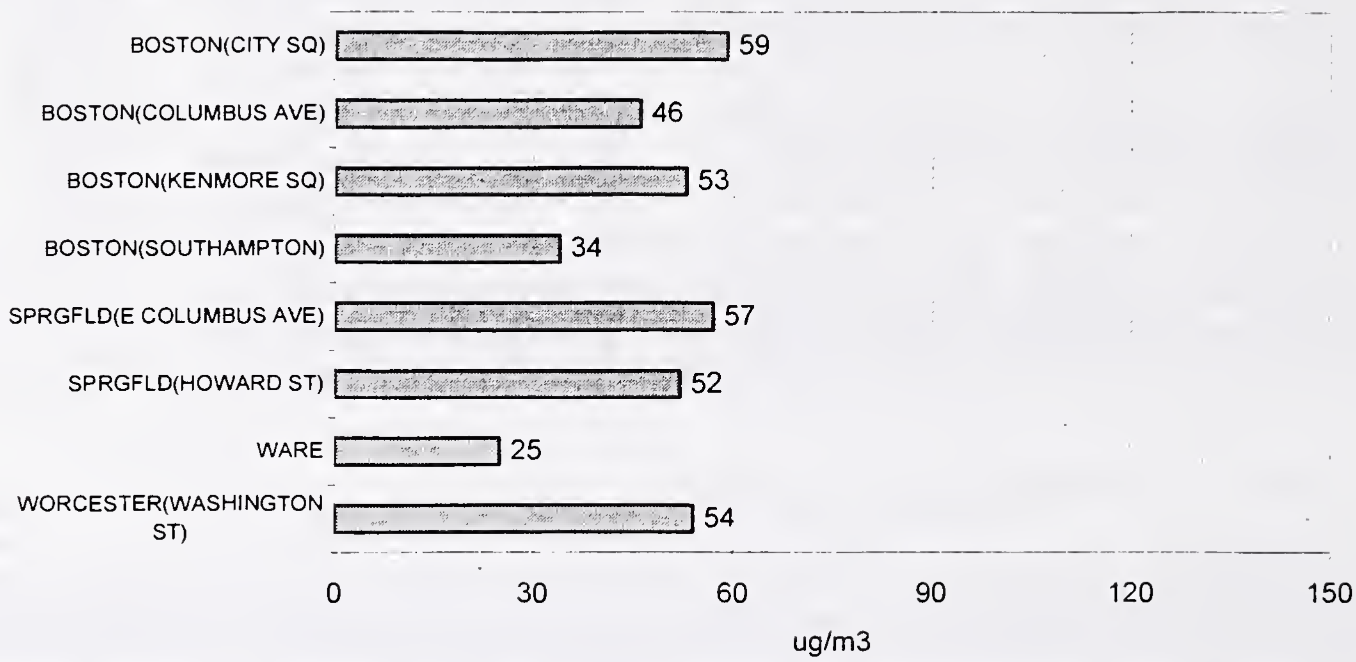


Figure 34

PM10 Annual Arithmetic Mean
Standard – 50 ug/m3

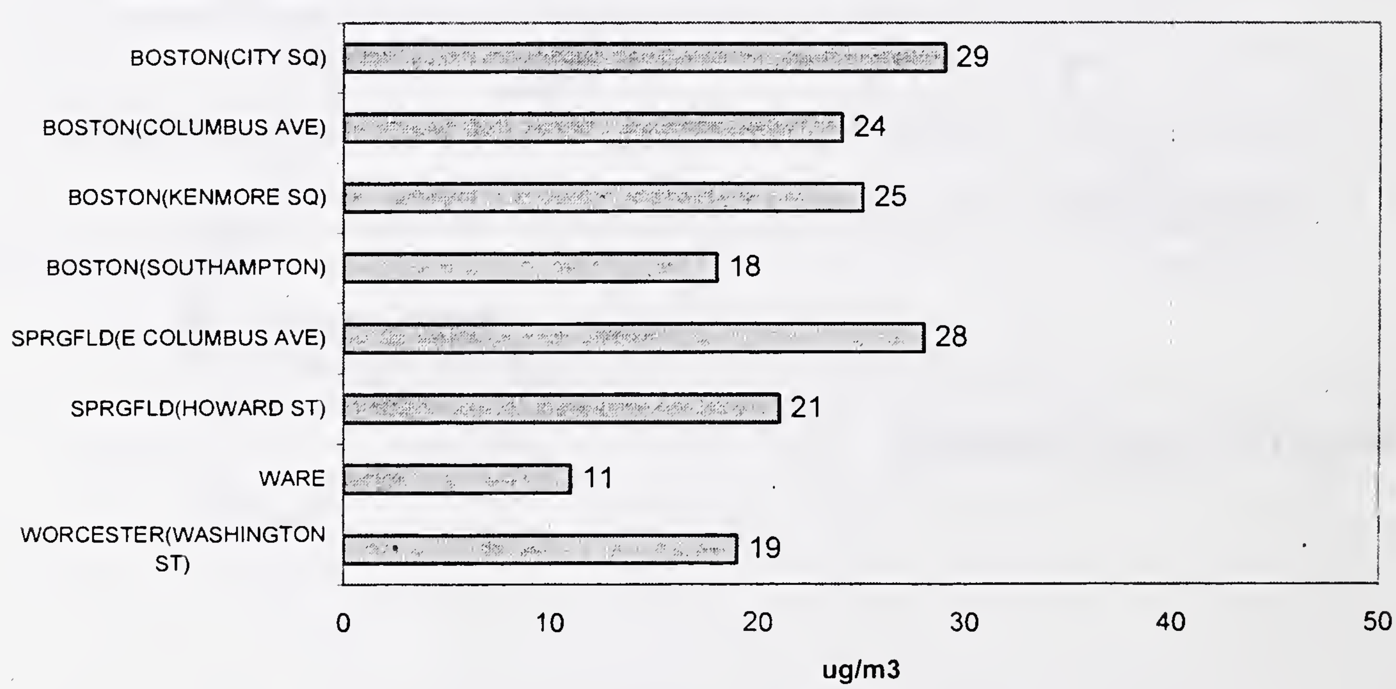


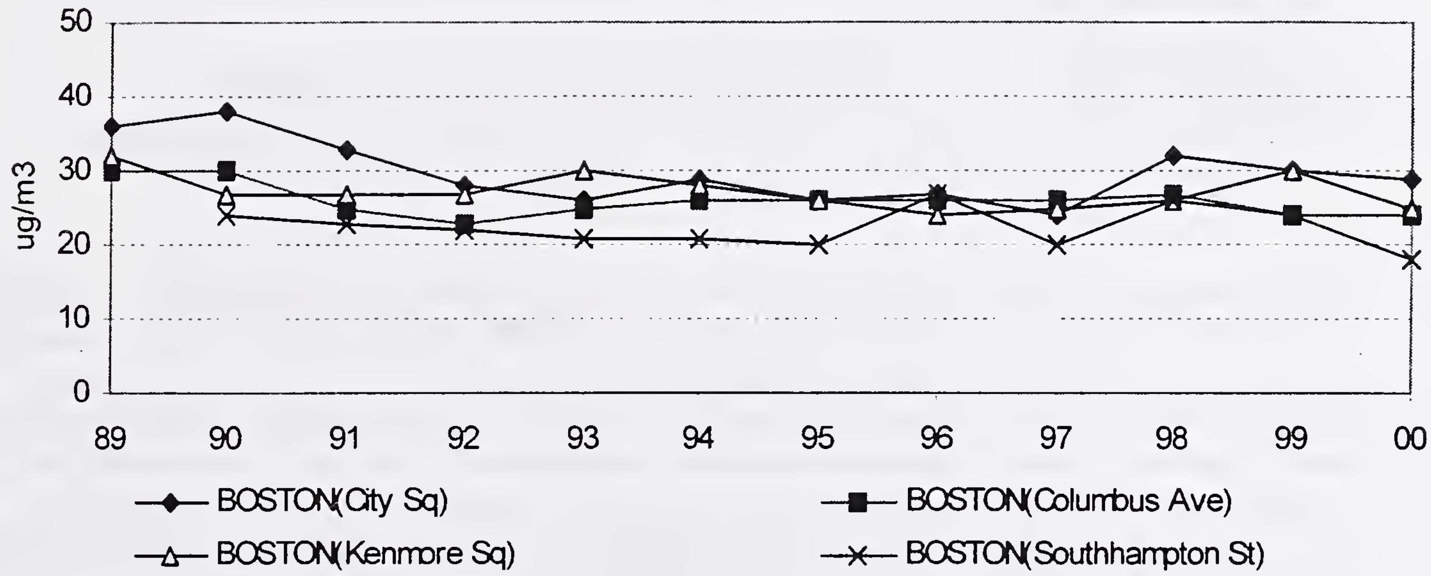
Figure 35

Particulate Matter 10-Microns (PM_{10}) Summary, Continued

PM_{10} trends

PM_{10} long-term trends are shown of the annual arithmetic mean for each PM_{10} site. The data shows a yearly variability at most sites, with the overall trend being downward.

PM10 Trends 1989-2000
Annual Arithmetic Mean
Standard = 50 ug/m3



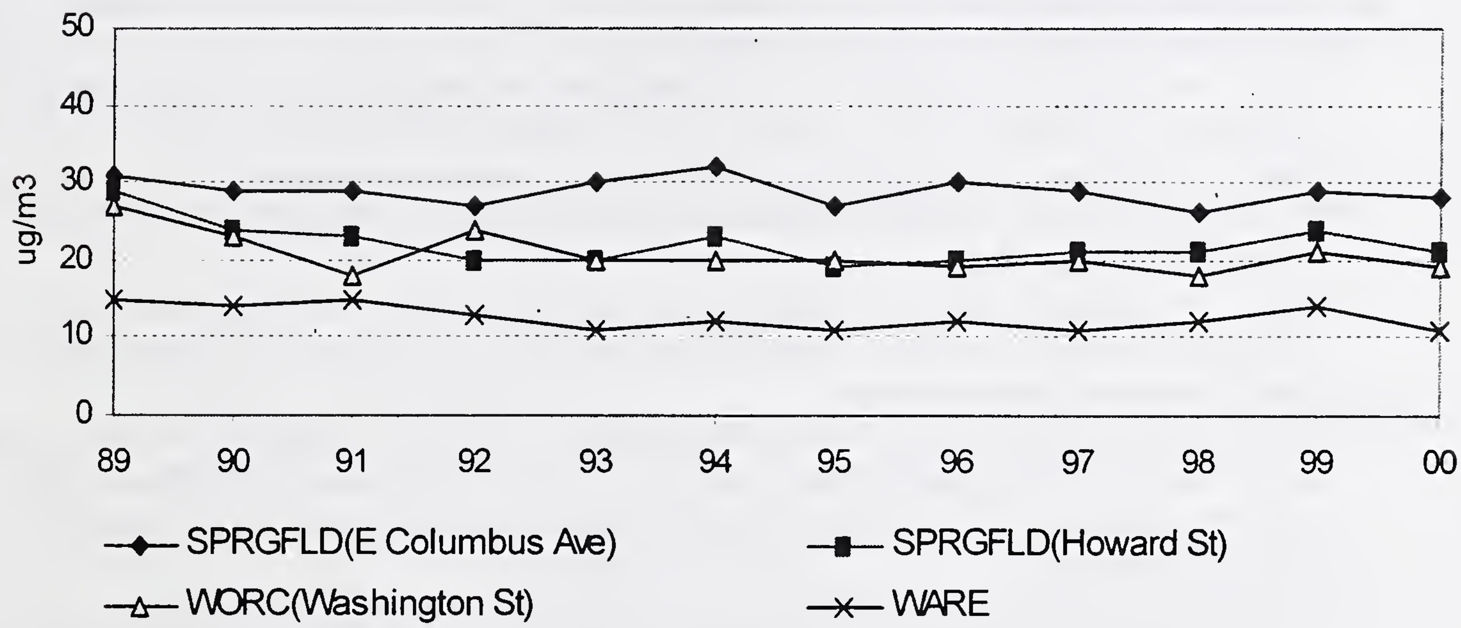


Figure 36

Particulate Matter 2.5-Microns ($PM_{2.5}$) Summary

Introduction

The $PM_{2.5}$ monitoring network was set up during late 1998 and monitoring began in January 1999. There were 21 $PM_{2.5}$ sites (five sites had collocated monitors) during 2000 in the state-operated monitoring network.

Particulate matter information

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, soot, smoke, and liquid droplets.
- The numbers 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.
- The small size of these particles allows entry into the respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and respiratory symptoms.
- Particulate matter causes soiling and corrosion of materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, agriculture, and construction activities.

The evolution of the particulate standard

On a periodic basis USEPA conducts a review of the national ambient air quality standards (NAAQS). The process includes a compilation and scientific assessment of all the health and environmental effects information available. The information that is gathered undergoes detailed reviews by the scientific community, industry, public interest groups, the general public, and the Clean Air Scientific Advisory Committee (CASAC) – a Congressionally mandated group of independent scientific and technical experts. Based on the scientific assessments and taking into account the recommendations of CASAC, the EPA administrator decides whether or not it is appropriate to revise the standards.

The particulate matter standard has evolved over the years as new studies have been published on the health effects of particulate matter. The trend has been to control particulates of smaller sizes and to more stringent concentrations, as studies have linked exposure to fine particles with adverse health effects.

- 1970 – The standard was based on Total Suspended Particulates (TSP). The standards were set at 260 ug/m^3 (24-hours) and 75 ug/m^3 (annual geometric mean).
- 1987 – The TSP standard was replaced by the PM_{10} standard (particulate matter less than 10 microns in size). The PM_{10} standards were set at 150 ug/m^3 (24-hours) and 50 ug/m^3 (annual arithmetic mean).
- 1997 – The $PM_{2.5}$ standard (particulate matter less than 2.5 microns) was promulgated in addition to the PM_{10} standard. The $PM_{2.5}$ standards are set at 65 ug/m^3 (24-hours) and 15 ug/m^3 (annual arithmetic mean).
- 2000 - The US Supreme Court heard oral arguments in USEPA's appeal of the Washington D.C. Circuit Court of Appeals May 1999 decision. The main question is whether setting a NAAQS under the Clean Air Act (CAA) is an unconstitutional delegation of legislative power by Congress.
- 2001 –Ruling made by the US Supreme Court upholding the USEPA's revised O_3 and $PM_{2.5}$ NAAQS, but remanding to The District Court for consideration of implementation issues.

Continued on next page

2000 $PM_{2.5}$ data capture problems

In 2000, $PM_{2.5}$ data collection improved greatly from that of 1999, the startup year. As familiarity with the methodology improved, data capture also improved. However, as the year progressed the durability of the sampling equipment came into question. The monitors did not perform well in winter conditions, and there were many problems that caused them to cease operation. Machine malfunctions caused 67% of all of the void $PM_{2.5}$ data samples in 2000. Collection error, the second most common reason to void data, accounted for only 11% of data loss.

Ongoing communications with the manufacturer has resulted in the receipt and installation of more durable parts and the enactment of a more stringent preventative maintenance program. While such increased effort impacts our ability to move forward with other monitoring activities, MADEP is counting on it to raise data capture to a percentage more consistent with the programs goals.

Designation of attainment for the $PM_{2.5}$ standard in Massachusetts is based on three years of data. The use of 2000 data for designation purposes will take into consideration data quality and capture concerns.

The $PM_{2.5}$ standard

The National Ambient Air Quality Standard is listed below. Designation for the $PM_{2.5}$ standard requires 3 years of data. 1999 was the first year of monitoring.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME	PRIMARY	SECONDARY
$PM_{2.5}$ Particulates up to 2.5 microns in size	Annual Arithmetic Mean	15.0 ug/m³	Same as Primary Standard
	24-Hour	65 ug/m³	Same as Primary Standard

- The annual standard is met when the annual average of the quarterly mean $PM_{2.5}$ concentrations is less than or equal to 15 ug/m³ (3-year average). If spatial averaging is used, the annual average from all monitors within the area may be averaged in the calculation of the 3-year mean.
- The 24-hour standard is met when 98th percentile value is less than or equal to 65 ug/m³ (3-year average).

µg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

Continued on next page

Particulate Matter 2.5-Microns (PM2.5) Summary, Continued

2000 $PM_{2.5}$ data summary

A summary of the 2000 data is listed below. Designation for the $PM_{2.5}$ standard requires 3 years of data. 1999 was the first year of monitoring. Data capture rates were better than in 1999 but more than one third are still low. See previous page for more information.

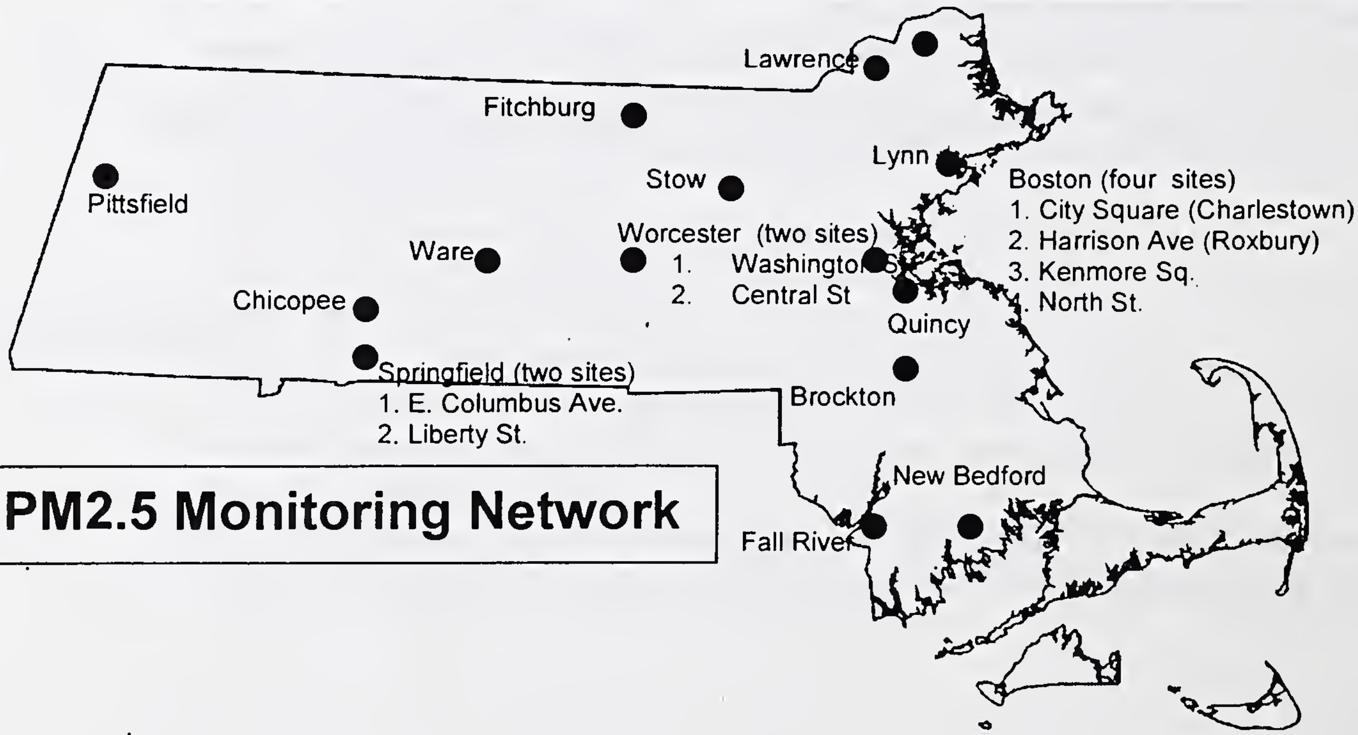
UNITS: UG/CU METER

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAX 24 HR VALUE 1ST	2ND	3RD	4TH	ARITH MEAN
25-025-0002	1	2	BOSTON	SUFFOLK	KENMORE SQUARE	76	35.5	29.5	27.6	27.1	13.53?
25-025-0027	1	2	BOSTON	SUFFOLK	ONE CITY SQUARE	42	38.9	38.2	38.0	35.9	13.87
25-025-0027	2	3	BOSTON	SUFFOLK	ONE CITY SQUARE	25	23.8	23.5	20.1	19.8	12.26?
25-025-0042	1	2	BOSTON	SUFFOLK	HARRISON AVENUE	76	36.9	36.0	34.7	34.1	12.95
25-025-0043	1	2	BOSTON	SUFFOLK	174 NORTH STREET	72	38.0	38.0	35.2	31.5	15.55
25-023-0004	1	2	BROCKTON	PLYMOUTH	120 COMMERCIAL ST.	78	27.3	25.7	25.5	25.4	10.59?
25-023-0004	2	3	BROCKTON	PLYMOUTH	120 COMMERCIAL ST.	70	27.3	26.1	24.6	23.8	9.80?
25-023-0004	3	2	BROCKTON	PLYMOUTH	120 COMMERCIAL ST.	53	28.0	25.7	24.6	22.0	11.61?
25-013-0008	1	2	CHICOPEE	HAMPDEN	ANDERSON ROAD	59	49.6	44.8	32.3	30.3	10.52
25-005-3001	1	2	FALL RIVER	BRISTOL	CENTRAL FIRE STATION	90	47.1	29.6	28.8	27.7	11.71
25-027-2004	1	2	FITCHBURG	WORCESTER	67 RINDGE ROAD	72	23.2	21.1	20.7	20.4	9.82
25-009-5005	1	2	HAVERHILL	ESSEX	WASHINGTON STREET	84	36.0	31.5	27.3	26.2	10.97
25-009-6001	1	2	LAWRENCE	ESSEX	37 SHATTUCK ST	59	25.6	19.1	19.0	18.4	9.78?
25-017-0008	1	2	LOWELL	MIDDLESEX	50 FRENCH STREET	44	27.4	21.1	16.9	16.6	9.98?
25-009-2006	1	2	LYNN	ESSEX	390 PARKLAND AVE.	76	28.0	27.2	26.3	22.9	11.45
25-005-2004	1	2	NEW BEDFORD	BRISTOL	YMCA,25 WATER ST.	70	29.3	27.6	27.4	26.2	11.83?
25-003-5001	1	2	PITTSFIELD	BERKSHIRE	78 CENTER STREET	87	45.2	38.4	28.8	26.2	11.85
25-021-0007	1	2	QUINCY	QUINCY	HANCOCK STREET	52	29.7	26.4	23.4	18.6	9.91?
25-021-0007	2	3	QUINCY	QUINCY	HANCOCK STREET	35	26.5	25.4	24.0	15.4	9.81?
25-013-0016	1	2	SPRINGFIELD	HAMPDEN	LIBERTY STREET	96	46.1	37.6	36.7	35.7	13.77
25-013-0016	2	3	SPRINGFIELD	HAMPDEN	LIBERTY STREET	75	47.0	38.0	36.6	33.0	13.24
25-013-2007	1	2	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVE.	82	52.4	39.5	37.2	36.5	15.35
25-017-1102	1	2	STOW	MIDDLESEX	US MILITARY RESERVAT.	60	28.3	26.8	19.2	18.4	9.23
25-015-4002	1	2	WARE	HAMPSHIRE	QUABBIN SUMMIT	92	28.1	26.0	25.2	21.7	8.85
25-027-0016	1	2	WORCESTER	WORCESTER	2 WASHINGTON STREET	85	34.0	27.4	26.6	26.0	11.81
25-027-0020	1	2	WORCESTER	WORCESTER	CENTRAL STREET	96	36.2	34.6	32.5	27.8	12.05
25-027-0020	2	3	WORCESTER	WORCESTER	CENTRAL STREET	70	34.6	31.8	28.9	27.2	11.92

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

Standards (based on 3-year averages): 24-hours = 65 μg/m³ Annual Arithmetic Mean = 15.0 μg/m³

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUE 1ST, 2ND, 3RD, 4TH** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **WTD ARITH MEAN** = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 15.0 μg/m³) **?** = INDICATES THAT NUMBER OF OBSERVATIONS WERE INSUFFICIENT TO CALCULATE MEAN. THE DATA CAPTURE AT A SITE MUST EXCEED 75% FOR EACH QUARTER.



2000 PM2.5 Monitoring Network

Lead (Pb) Summary

Introduction

As required by USEPA, lead monitoring was reinstituted in 1998 after being discontinued in July 1995. The concentrations monitored are very low. The use of unleaded gasoline has greatly diminished lead emissions, since the primary source for airborne lead is motor vehicles. Lead monitoring was reinstated at the Kenmore Square, Boston, location in 1998 in an effort to continue the tracking of long-term lead concentration trends.

Lead health effects

- Exposure to lead may occur by inhalation or ingestion of food, water, soil or dust particles.
- Children, infants, and fetuses are more susceptible to the effects of lead exposure.
- Lead causes mental retardation, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.
- The primary source for airborne lead used to be motor vehicles, but the use of unleaded gasoline has greatly reduced those emissions. Other sources are lead smelters and battery plants.

The Lead standard

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME	PRIMARY	SECONDARY
Pb	Calendar Quarter Arithmetic Mean	1.5 ug/m³	Same as Primary Standard

µg/m³ = micrograms per cubic meter **ppm** = parts per million **mg/m³** = milligrams per cubic meter

Continued on next page

Lead (Pb) Summary, Continued

2000 Pb data summary

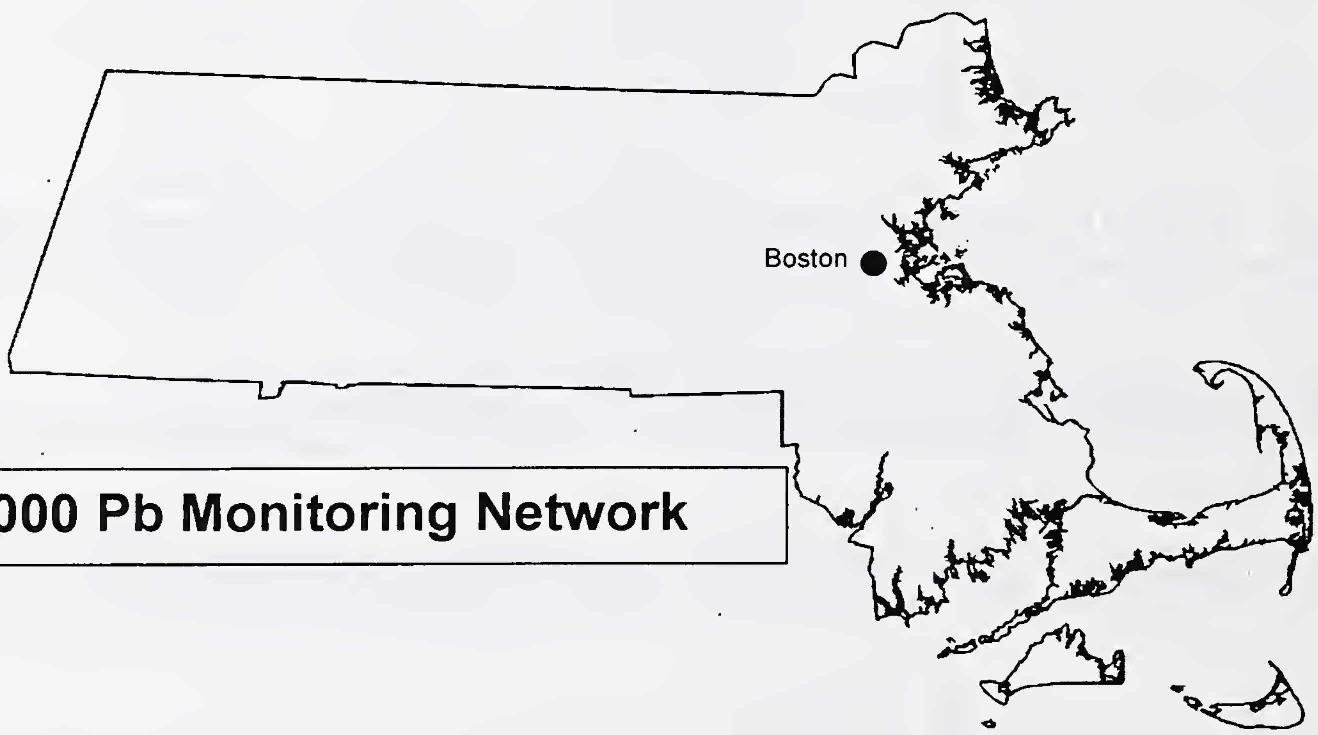
A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	QUARTERLY ARITH MEANS 1ST	2ND	3RD	4TH	MEANS >1.5	MAX VALUES 1ST	2ND
					UNITS: UG/CU METER								
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQ.	91	.01	.02	.02	.02	0	.09	.08

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

Standard: 1.5 µg/m³ (Calendar Quarter Arithmetic Mean)

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **QUARTERLY ARITH MEANS 1ST,2ND,3RD,4TH** = THE MEANS FOR THE 1ST,2ND,3RD AND 4TH CALENDAR QUARTERS **MEANS > 1.5** = THE NUMBER OF CALENDAR QUARTER MEANS GREATER THAN THE STANDARD (1 5 UG/M3) **MAX VALUES 1ST, 2ND** = THE 1ST & 2ND MAXIMUM 24 HOUR VALUES



2000 Pb Monitoring Network

Acid Deposition

What is acid deposition?

Acid deposition occurs when acidic substances fall to the earth's surface from the atmosphere. The emissions of sulfur dioxide (SO_2) and the oxides of nitrogen (NO_x) react in the atmosphere with water and oxygen to form acidic compounds, such as sulfuric acid and nitric acid. These compounds are returned to the earth in precipitation (such as rain, snow or fog), or in dry form as gas and particles.

Effects of acid deposition

Acid deposition causes acidification of surface waters, which jeopardize the aquatic ecosystem by diminishing and in some cases eradicating fish species. It contributes to forest degradation and adversely affects soils, influencing the yields of some crops. The formation of acidic particles in the atmosphere leads to haze and visibility reduction. Acid deposition also is responsible for the corrosion and deterioration of materials and buildings through its effect on stone, metals and paints.

Monitoring in Massachusetts

One National Atmospheric Deposition Program (NADP) acid rain site is located in Waltham and run by MADEP. There are two additional sites in Truro and Ware. The NADP is a cooperative effort that consists of a nationwide network of more than 200 precipitation monitoring sites. The NADP has a web site at nadp.sws.uiuc.edu.

Wet precipitation for each week is collected and tested for acidity and conductivity. It is then sent to a central lab in Illinois, where it is analyzed for compounds including sulfate (SO_4), nitrate (NO_3), and hydrogen (acidity as pH).

Continued on next page

Acid deposition trends

Figure 37 shows the trend for the pH of precipitation, which is an indicator of acidity. The long-term trend shows the pH is increasing and is therefore less acidic. This means the precipitation is less harmful to the environment.

Distilled water that has equilibrated with carbon dioxide (CO2) in the laboratory has a pH of 5.6. Monitoring conducted by the National Oceanic and Atmospheric Administration (NOAA) at remote sites around the world shows a pH in the 5.0 range. Since pH is on a logarithmic scale, Massachusetts precipitation is 5 to 10 times more acidic than unpolluted precipitation.

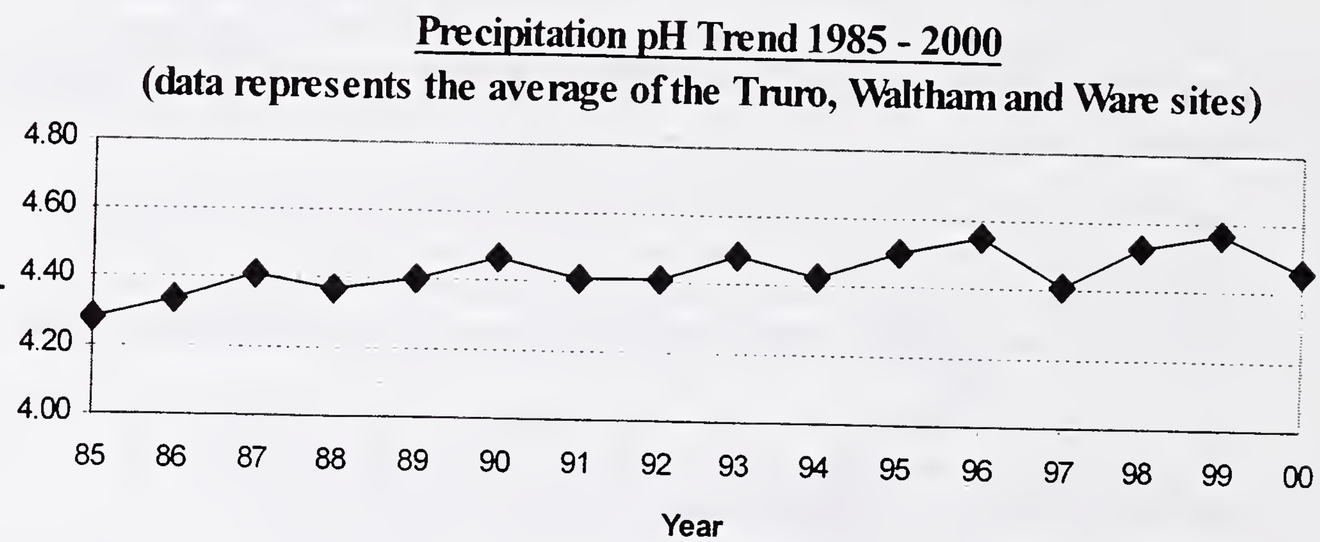


Figure 37

Acid deposition trends,

Figure 38 shows the long-term trends for nitrate (NO_3) and sulfate (SO_4), which result from the emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) into the atmosphere. These compounds are harmful to the quality of surface waters. SO_4 increases acidity, and NO_3 increases acidity and can cause algae blooms.

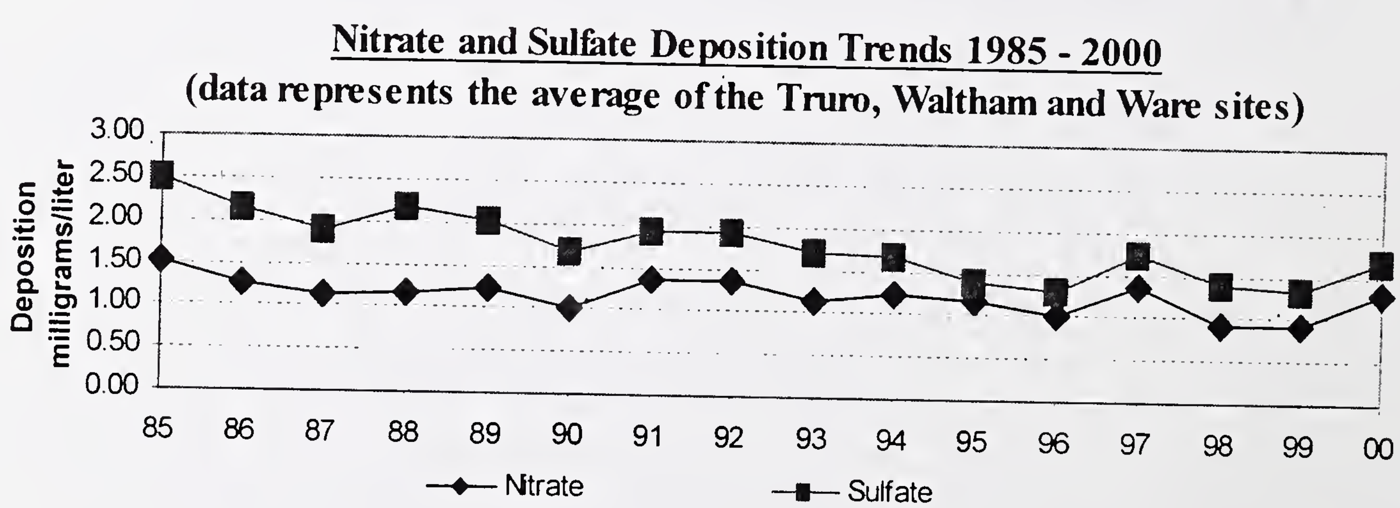


Figure 38

Industrial Network Summary

Introduction

The industrial ambient air quality network is comprised of monitoring stations operated by industries with facilities that may potentially emit large amounts of pollutants. An example would be a coal-burning power plant, which emits SO_2.

The monitoring stations in the industrial network are sited to measure the maximum values from the specific point source. When the pollutant (SO_2) value reaches certain trigger values, the power plant switches to lower sulfur-content fuel.

The data from the industrial network is submitted to the Air Assessment Branch. It is submitted into the USEPA AIRS database after the quality assurance process has been completed.

The Continuous Emission Monitoring System (CEMS)

The ambient monitoring network is different from, and in addition to, the in-stack Continuous Emission Monitoring System (CEMS) equipment which is required at certain facilities by a MADEP-issued permit or other state and federal regulations. For example, the federal Acid Rain Program requires CEMS enabling calculation of SO_2, NO_x and CO_2 emissions from the nation's largest power generating facilities. The information on emissions collected by those monitors can be found on USEPA's web site (www.epa.gov/acidrain).

Sulfur Dioxide (SO_2) summary

There were six SO_2 sites during 2000 in the industrial network. Three of the sites achieved the requirement of 80% or greater data capture for the year. There were no known violations of the SO_2 air quality standards during the year in the reported data. However, two sites have not yet reported 2000 data. The Dewar St. site was not functional from July 17th through November 1st due to a transformer fire on the abutting property. The oil from the transformer leaked into the ground underneath the site trailer, and cleanup and repair of the site took the entire period.

A summary of the 2000 data is listed below.

	P			UNITS: PPM									
	C	M				REP	%	MAX	24-HR	MAX	3-HR	MAX	1-HR	ARIT
SITE ID	C	T	CITY	COUNTY	ADDRESS	ORG	OBS	1ST	2ND	1ST	2ND	1ST	2ND	MEAN
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	5	95	.023	.019	.042	.041	.065	.062	.004
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	5	68	.035	.035	.055	.049	.063	.055	.006?
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMEN ST.	5	95	.029	.027	.054	.047	.061	.060	.006
25-025-0040	1	4	BOSTON	SUFFOLK	531A E. FIRST ST	5	95	.032	.030	.067	.057	.089	.072	.006
25-017-1701	1	4	STONEHAM	MIDDLESEX	HILL STREET	25	N/A							
25-009-5004	1	4	HAVERHILL	ESSEX	NETTLE SCHOOL	2	N/A							

TO CONVERT UNITS FROM PPM TO mG/M³ MULTIPLY PPM x 2620

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **REP ORG** = REPORTING ORGANIZATION **%OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG. GREATER THAN 0 14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG GREATER THAN 0 50 PPM (3-HR STANDARD) **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0 030 PPM)

Continued on next page

Nitrogen Dioxide (NO_2) summary

There was one NO_2 site during 2000 in the industrial network, operated by Sithe New England in Boston (East First St.). It met the requirement of 80% or greater data capture. There were no violations of the NO_2 air quality standard during the year. The annual arithmetic mean was 0.020 ppm, which is 40% of the standard.

A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAX 1-HR 1ST	MAX 1-HR 2ND	ARIT MEAN
					UNITS: PPM				
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST ST	94	.095	.076	.020

TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 1886.8

PRIMARY STANDARD: ANNUAL ARITHMETIC MEAN = 0.053 PPM

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **%OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0.053 PPM)

Total Suspended Particulates (TSP) summary

There were four TSP sites during 2000 in the industrial network, all operated by Sithe New England in the city of Boston. Three sites met the requirement of 80% or greater data capture. Dewar St. was down from July 17th through November 1st due to a transformer fire in the area.

TSP is not a criteria pollutant (PM_{10} replaced it as the particulate standard in 1987), so there is no longer a standard for it. The highest 24-hour value was 253 ug/m3 at the East First St. site, which is 97% of the old standard (260 ug/m3). The highest annual geometric mean was 50 ug/m3 at the East First St. site, which is 63% of the old standard (75 ug/m3).

A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAXIMUM 24-HR VALUES 1ST	2ND	3RD	4TH	ARITH MEAN	GEO MEAN	GEO STD
					UNITS: UG/CU METER (25C)								
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	96	79	69	51	47	29	28	1.4
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	70	110	76	66	66	44?	41?	1.4
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMEN ST	100	145	135	120	106	55	51	1.5
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	100	188	76	75	75	47	43	1.4
25-025-0040	2	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	100	187	84	82	76	47	44	1.5

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN **GEO MEAN** = GEOMETRIC MEAN **GEO STD** = GEOMETRIC STANDARD DEVIATION

Continued on next page

Industrial Network Summary, continued

Sulfate (SO_4) summary

There were four SO_4 sites during 2000 in the industrial network, all operated by Sithe New England in the city of Boston. Three met the requirement of 80% or greater data capture.

There are no standards for SO_4, since it is not a criteria pollutant. The highest 24-hour value, 31 Tg/m^3, was measured at East First St. The highest annual arithmetic mean was 8.17 Tg/m^3 at Bremen St.

A summary of the 2000 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	1ST	2ND	3RD	4TH	ARITH MEAN
					UNITS: UG/CU METER (25C)		-MAXIMUM VALUES-				
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	96	23.0	13.0	12.0	12.0	7.51
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	70	16.0	13.0	12.0	12.0	7.91?
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMEN STREET	100	19.0	16.0	15.0	14.0	8.80
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	100	19.0	14.0	13.0	13.0	8.39
25-025-0040	2	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	100	18.0	14.0	14.0	12.0	8.39

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN

Quality Control and Quality Assurance

Introduction

To ensure that the ambient air quality data is of high quality, MADEP has developed standard operating procedures (SOPs). These procedures include quality control and quality assurance techniques that assess the quality and document the activities performed in collecting the data.

Quality control

Quality control (QC) is comprised of those activities performed by personnel who are directly involved in the generation of the data. Examples of personnel who perform QC functions are site operators and laboratory support personnel. QC activities include calibrations, data validation procedures, and performance checks of the ambient air monitors to assess the precision of the data.

Data quality review

The AAB data group reviews data. All precision and accuracy activities are checked as well as raw data, quality assurance checks, and documentation. Report software also is utilized for data validation. The data group edits the data as required and it is then transferred into the USEPA AIRS Database.

Quality assurance

Quality assurance (QA) is comprised of those activities performed by personnel who are not directly involved in the generation of the data and who may therefore make an unbiased assessment of the data quality. QA activities include performance audit checks of the ambient air monitors to assess the accuracy of the data.

Precision and accuracy

Precision is defined as a measure of the repeatability of a measurement system. Accuracy is defined as a measure of the closeness of an observed measurement value to the actual value.

The QC and QA performance checks allow the precision and accuracy of ambient air monitors to be quantified. Testing the monitor's response to known inputs in order to assess the measurement error does this. The QC performance checks assess the precision, while the QA performance checks assess the accuracy.

The requirements and techniques for performing precision and accuracy performance checks are established in the Code of Federal Regulations (CFR), Title 40, Part 58, Appendix A.

How precision and accuracy is described

Precision and accuracy are given in the context of upper and lower 95-percentile probability limits for each pollutant parameter. The meaning of the 95-percentile limits is that 95% of the data for a parameter is estimated to be precise or accurate to within the percentage range defined by the upper and lower limits. As an example, if the upper and lower 95-percentile-limits for a parameter based upon precision checks are calculated to be +4.3% and –7.4%, then 95% of the data is precise within the range of +4.3 through –7.4%.

Continued on next page

Quality Control and Quality Assurance, Continued

2000 Precision and accuracy summary

As a goal, the 95-percentile probability limits for precision (all parameters) and PM_{10} and TSP accuracy should be less than ±15%. The 95 percentile probability limits for accuracy for all other parameters should be less than ±20%. Three response levels are audited; low (L1) 6-16% of full scale, mid (L2) 30- 40%, and high (L3) 70-90%. A summary of the data is listed below.

							PRECISION DATA				ACCURACY DATA						
PRECISION AND ACCURACY DATA KEY							# OF	PRECIS	PROB	LIM	# AUDITS	PROB	LIM	PROB	LIM	PROB	LIM
RG	ST	RO	TYP	CLASS	POLL	YEAR-Q	ANLYZRS	CHECK	LO	UP	L1-3	LO-L1	-UP	LO-L2	-UP	LO-L3	-UP
01	25	001	C	A	CO	2000	8	190	-07	+07	14	-09	+04	-12	+04	-12	+02
CARBON MONOXIDE						2000-1	8	46	-07	+08	3	-10	+08	-15	+09	-13	+07
						2000-2	8	50	-07	+03	4	-10	+03	-11	+03	-09	+00
						2000-3	8	49	-05	+05	3	-05	+00	-10	-01	-09	-03
						2000-4	8	45	-04	+07	4	-12	+09	-14	+10	-16	+08
01	25	001	C	A	SO2	2000	8	190	-11	+06	12	-05	+07	-07	+09	-07	+07
SULFUR DIOXIDE						2000-1	7	45	-09	+04	3	-04	-02	-06	-02	-07	-04
						2000-2	8	46	-12	+07	3	-07	+08	-07	+09	-04	+03
						2000-3	8	49	-07	+00	3	-09	+12	-12	+16	-11	+12
						2000-4	8	50	-11	+05	3	-01	+04	+00	+06	+00	+05
01	25	001	C	A	NO2	2000	13	265	-11	+09	17	-13	+04	-15	+05	-13	+06
NITROGEN DIOXIDE						2000-1	5	31	-05	+05	4	-20	+10	-13	+03	-10	+04
						2000-2	12	77	-11	+08	4	-15	+01	-18	+04	-14	+06
						2000-3	13	85	-07	+05	4	-05	+01	-08	+07	-07	+08
						2000-4	13	72	-12	+11	5	-13	+04	-15	+04	-15	+03
01	25	001	C	A	O3	2000	15	241	-05	+05	30	-05	+10	-05	+10	-05	+10
OZONE						2000-1	2	14	-05	-01	0						
						2000-2	15	97	-06	+05	13	-04	+12	-05	+11	-05	+12
						2000-3	15	104	-04	+05	14	-08	+10	-07	+10	-07	+09
						2000-4	4	26	-05	+06	3	-02	+06	-19	+16	-18	+16

							PRECISION DATA				ACCURACY DATA						
PRECISION AND ACCURACY DATA KEY							# OF	COLLC	PROB	LIM	VAL COLL		#	PROB	LIM	PROB	LIM
RG	ST	RO	TYP	CLASS	POLL	YEAR-Q	SMPLS	SITES	LO	UP	DATA PRS		AUD	LO-L1	-UP	LO-L2	-UP
01	25	001	I	F	PM2.5	2000	332	5	-20	+18	328		91			-03	+03
PM2.5 LOCAL CONDITIONS						2000-1	77	5	-16	+12	77		22			-04	+03
						2000-2	112	5	-20	+17	110		24			-04	+04
						2000-3	82	4	-24	+22	82		27			-03	+03
						2000-4	61	3	-17	+21	59		18			-05	+04
01	25	001	I	F	PM10	2000	114	3	-10	+12	74		18			-04	+10
PM10 TOTAL 0-10UM						2000-1	44	3	-09	+16	32		4			-02	+10
						2000-2	22	2	-05	+08	10		4			-04	+11
						2000-3	23	2	-10	+07	18		6			-07	+08
						2000-4	25	2	-11	+06	14		4			-01	+12
01	25	001	I	F	LEAD	2000	0	0			0		2			-03	+12
LEAD (TSP)						2000-1	0	0			0		0				
						2000-2	0	0			0		1			+02	+02
						2000-3	0	0			0		0				
						2000-4	0	0			0		1			+07	+07

ABBREVIATIONS AND SYMBOLS USED IN TABLE
RG = EPA REGION **ST** = STATE **RO** = REPORTING ORGANIZATION **TYP** = ANALYZER TYPE (CONTINUOUS OR INTERMITTENT) **CLASS** = ANALYTICAL (A); FLOW (F) **YR** = YEAR **# OF ANLYZRS** = NUMBER OF ANALYZERS **PRECIS CHECKS** = NUMBER OF PRECISION CHECKS **PROB LIM LO/UP** = LOWER AND UPPER 95% PROBABILITY LIMITS **# AUDITS L1-3** = NUMBER OF AUDITS **PROB LIM LO-L1-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT LOW RANGE **PROB LIM LO-L2-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT MIDDLE RANGE **PROB LIM LO-L3-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT HIGH RANGE **# OF SMPLS** =NUMBER OF SAMPLERS **COLLC SITES** = NUMBER OF COLLOCATED SITES **VAL COLL DATA PRS** = NUMBER OF VALID COLLOCATED SAMPLES (ABOVE THE LIMIT USED FOR PRECISION CALCULATION) **# AUD** = NUMBER OF AUDITS

Precision data summary

The figure below presents the precision summary for all parameters in 2000. The precisions are within acceptable limits except for $PM_{2.5}$.The error range for $PM_{2.5}$ is attributed to machine malfunctions. However, the precision did improve greatly from last year +29% & -32% for 1999 versus +18% & -20% for 2000.

2000 Precision Summary
Upper and lower 95% probability limits

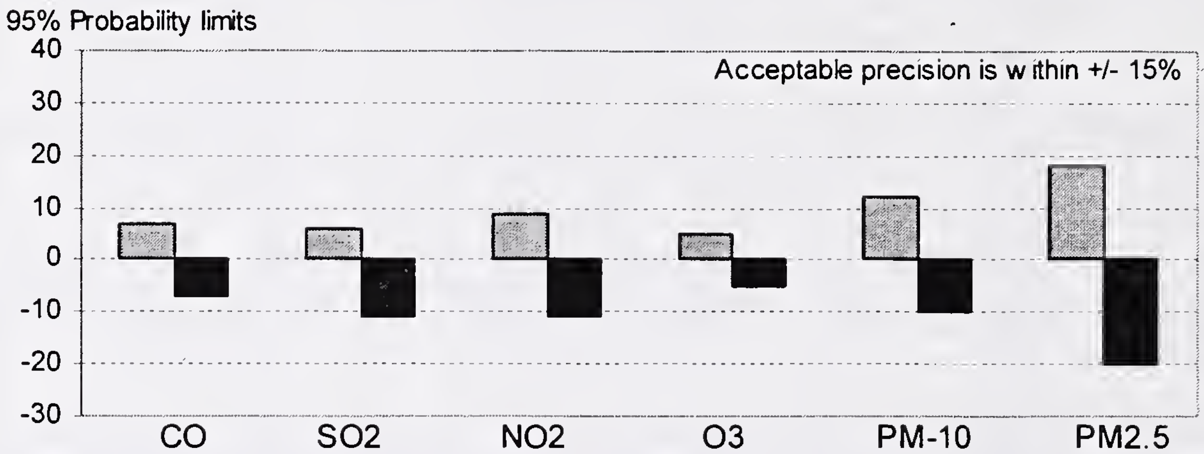


Figure 39

	CO	SO_2	NO_2	O_3	PM_{10}	$PM_{2.5}$
Upper	+7%	+6%	+9%	+5%	+12%	+18%
Lower	-7%	-11%	-11%	-5%	-10%	-20%

CO accuracy summary

The figure below presents the CO accuracy summary for 2000. The results were within acceptable limits.

2000 CO Accuracy Summary
Upper and lower 95% probability limits

Figure 40

	Level 1 (low)	Level 2 (mid)	Level 3 (high
Upper	+4%	+4%	+2%
Lower	-9%	-12%	-12%

Continued on next page

NO_2 accuracy summary

The figure below presents the NO_2 accuracy summary for 2000. The results were within acceptable limits.

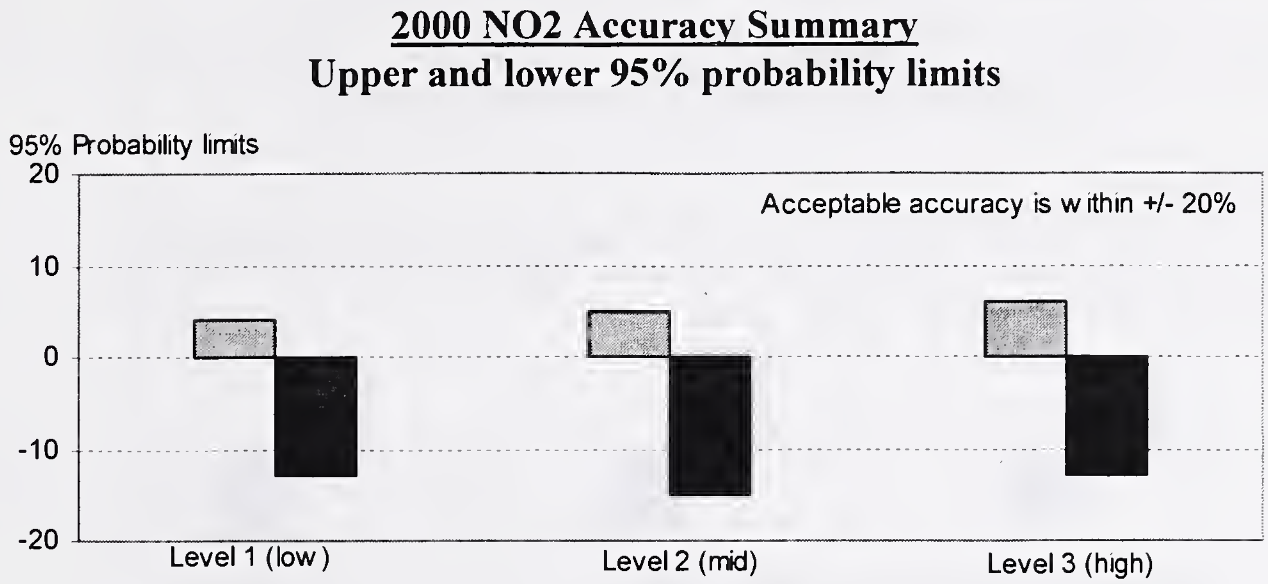


Figure 41

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+4%	+5%	+6%
Lower	-13%	-15%	-13%

O_3 accuracy summary

The figure below presents the O_3 accuracy summary for 2000. The results were within acceptable limits.

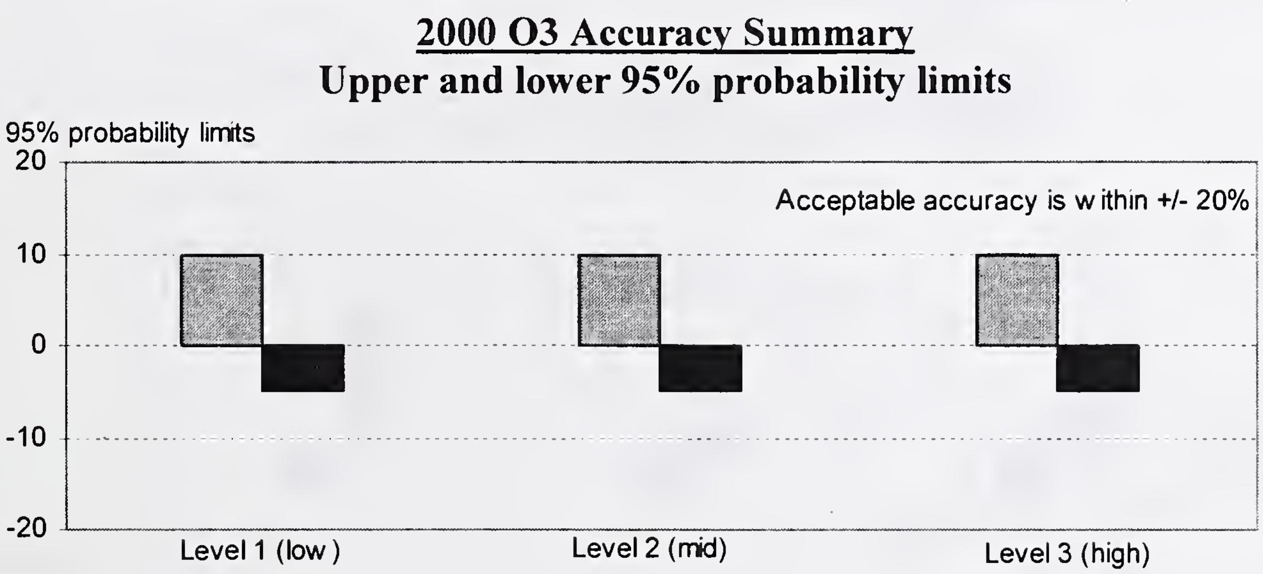


Figure 42

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+10%	+10%	+10%
Lower	-5%	-5%	-5%

Continued on next page

SO_2 accuracy summary

The figure below presents the SO_2 accuracy summary for 2000. The results were within acceptable limits.

2000 SO2 Accuracy Summary
Upper and lower 95% probability limits

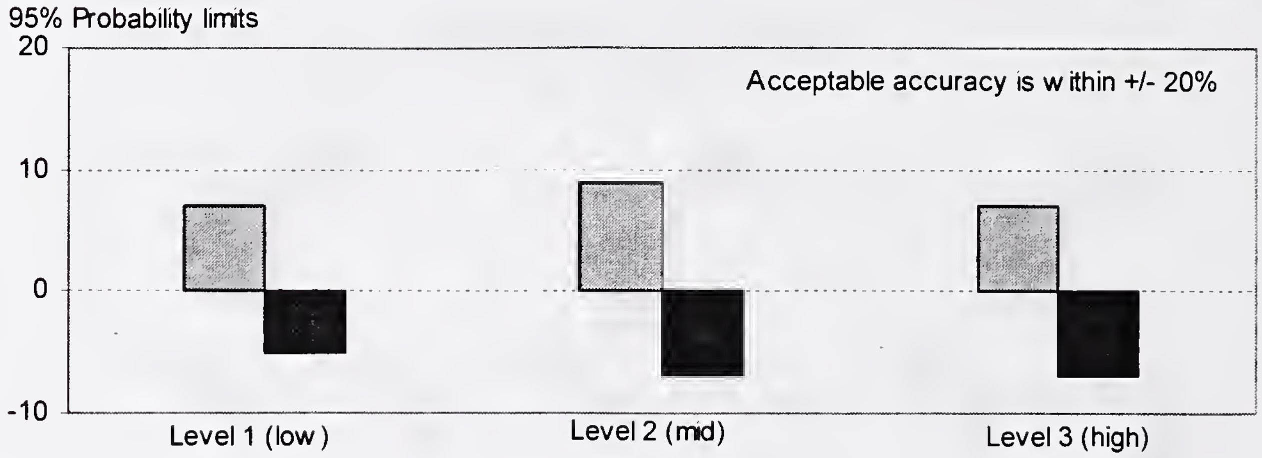


Figure 43

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+7%	+9%	+7%
Lower	-5%	-7%	-7%

PM_{10}, $PM_{2.5}$ & Lead accuracy summary

The figure below presents the PM_{10}, $PM_{2.5}$ and Lead accuracy summaries for 2000. The results were within acceptable limits.

2000 PM_{10}, $PM_{2.5}$ & Lead Accuracy Summary
Upper and lower 95% probability limits

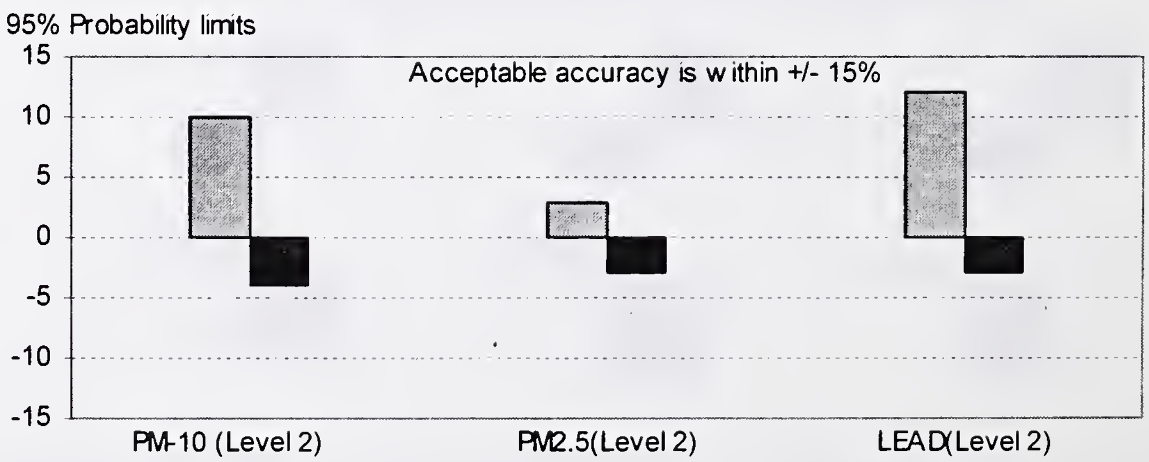


Figure 44

	PM_{10} (Level 2)	$PM_{2.5}$ (Level 2)	LEAD (Level 2)
Upper	+10%	+3%	+12%
Lower	-4%	-3%	-3%

Air Quality Levels By Region

Introduction

The Pollutant Standards Index (PSI) was developed by USEPA and provides a uniform way of presenting air pollution levels and rating the impact on public health for five major pollutants regulated under the Clean Air Act. The pollutants are ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter – PM_{10} (particulates less than 10 microns) and $PM_{2.5}$ (particulates less than 2.5 microns). This index was updated in 2001 to include more parameters and renamed The Air Quality Index (AQI).

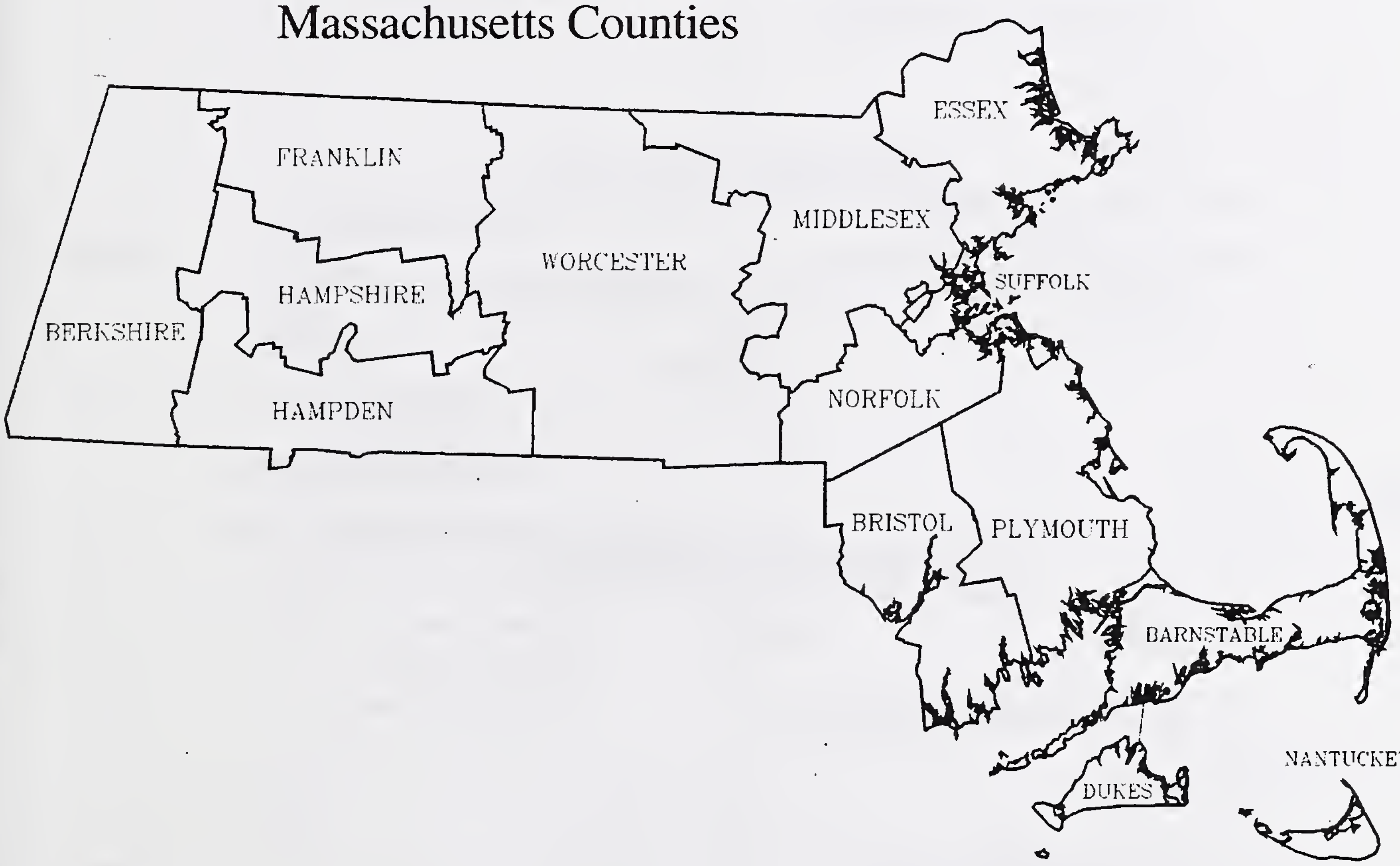
The PSI value for each parameter represents the annual mean of each day's PSI. Since NO_2 does not have a short-term daily federal standard, a PSI value was calculated using the NO_2 annual mean and comparing that to the federal standard.

Massachusetts regions

The PSI values are presented in this section by regions. The state has been divided by county into four regions.

- Northeast region – Essex, Middlesex, and Suffolk counties
- Southeast region – Norfolk, Bristol, Plymouth, and Barnstable counties
- Central region – Worcester county
- West region – Franklin, Hampshire, Hampden, and Berkshire counties

Massachusetts Counties



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Understanding PSI levels

The PSI level converts the measured concentration of a pollutant to a number on a scale of 0 to 500. A PSI rating of 100 corresponds to the National Ambient Air Quality Standard (NAAQS) for that pollutant.

The categories of the PSI air quality levels are:

- Good: from 0 to 50
- Moderate: from 50 to 100
- Unhealthful: from 100 to 200
- Very unhealthful: from 200 to 300
- Hazardous: above 300.

PSI levels by region

The figures below present the 2000 PSI levels for the pollutants monitored in each region. The PSI levels are the average for the year of all sites in the region. All of the PSI levels are below 50, in the Good category.

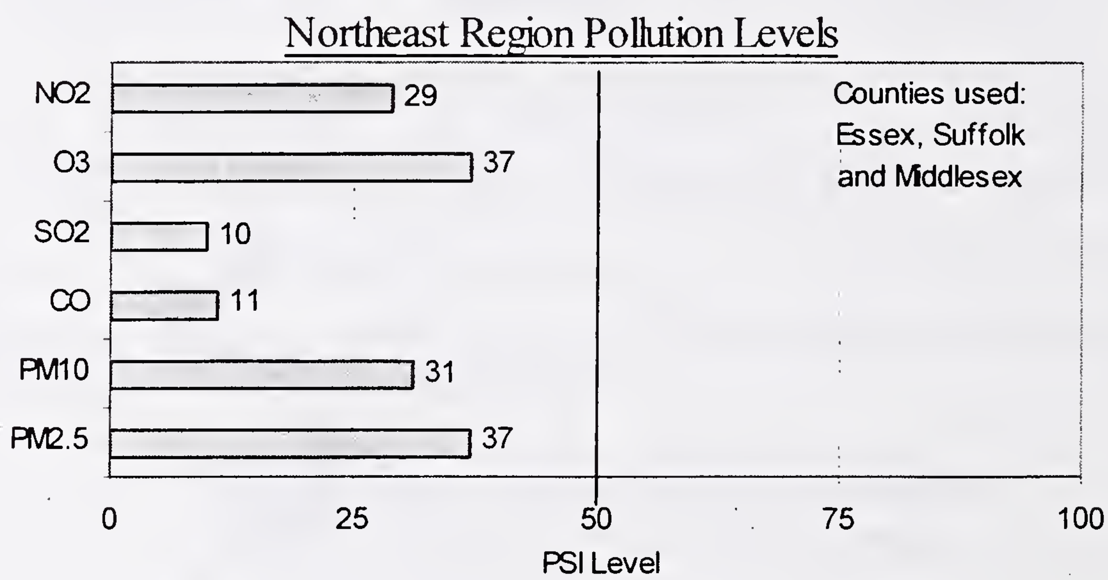

Figure 45

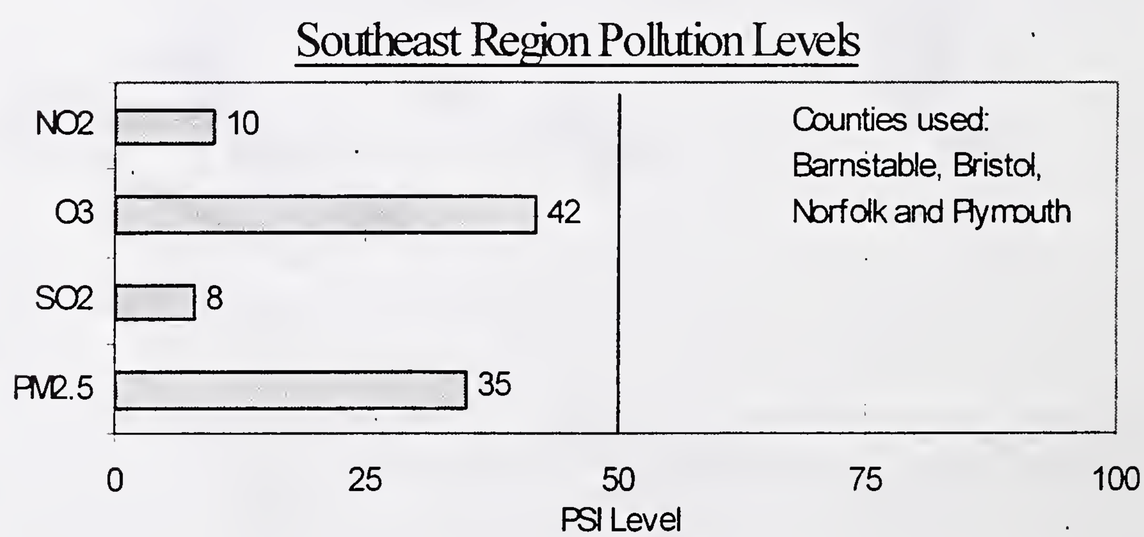

Figure 46

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PSI levels by region, Continued

The figures below present the 2000 PSI levels for the pollutants monitored in each region. The PSI levels are the average for the year of all sites in the region. All of the PSI levels are below 50, in the Good category.

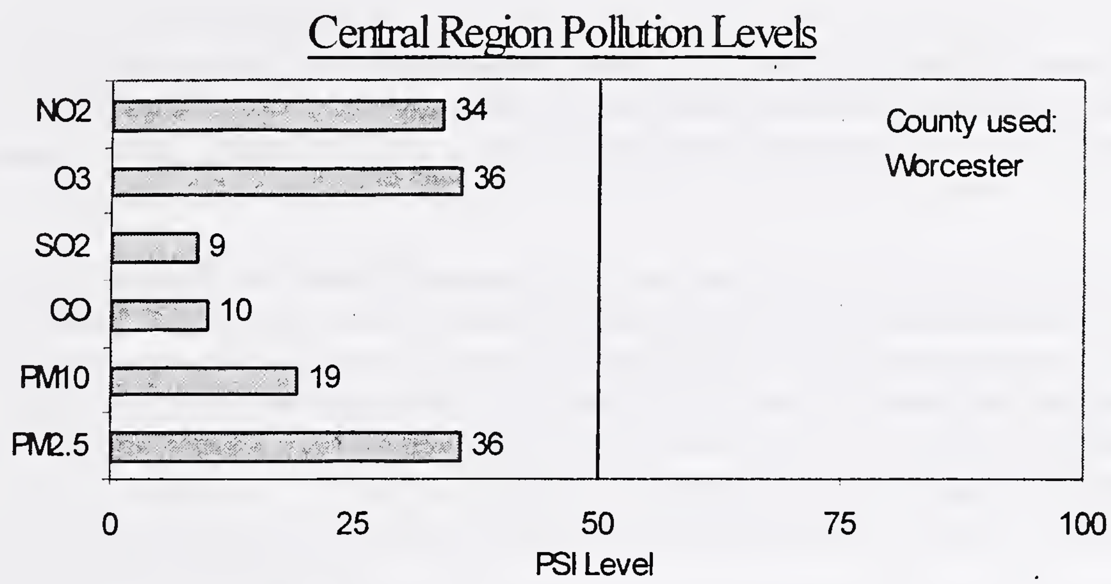

Figure 47

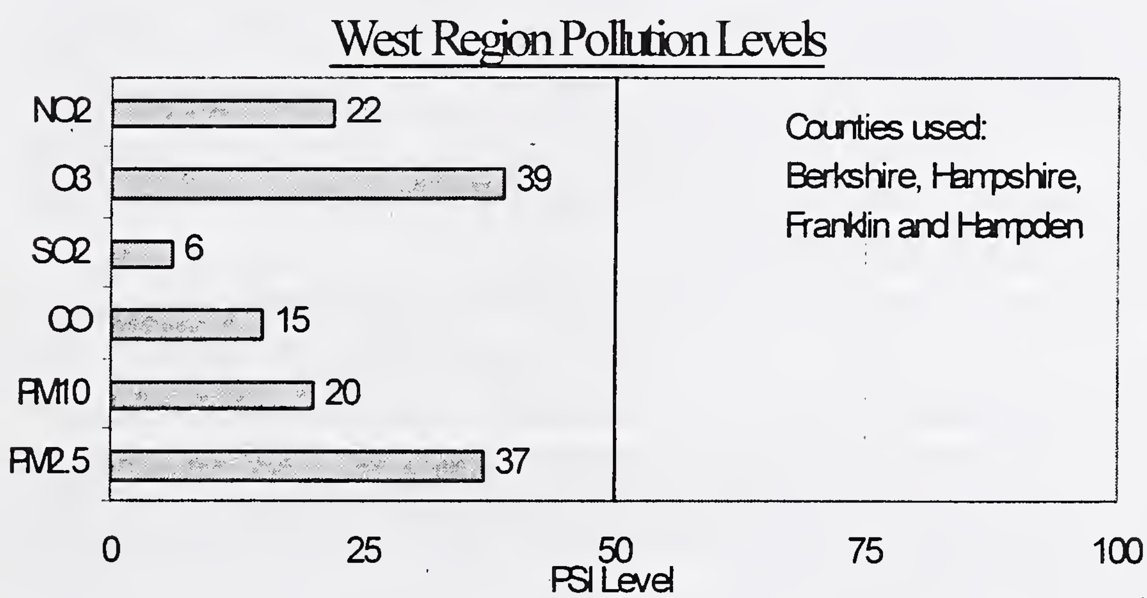

Figure 48

Section IV

PAMS/Air Toxics Monitoring

PAMS Monitoring

Introduction

Non-criteria air pollutants are those pollutants that are monitored in the ambient air for which National Ambient Air Quality Standards (NAAQS) do not exist. This category covers toxic air pollutants (toxic volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), toxic elements, and other gases and particles), and organic ozone precursors and products (PAMS components).

Since 1993, most efforts to monitor non-criteria pollutants have been associated with the PAMS (Photochemical Assessment Monitoring Stations) project. This project, which was mandated by the 1990 Federal Clean Air Act Amendments, requires that state agencies measure a comprehensive list of pollutants and meteorological parameters related to the formation of ozone (O_3) and other harmful photochemical oxidants during the summer months.

Understanding ozone (O_3) generation

Ozone is unique in that it is formed by reactions between other pollutants in presence of intense high-energy sunlight during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground level ozone concentrations far downwind from the original source of the precursors.

Although this complex reaction system has stymied efforts to fully understand critical ozone formation parameters, it is well known that oxides of nitrogen and light sensitive (photo-reactive) volatile organic compounds are the major ozone precursors. The PAMS program represents the first consistent effort to measure ozone precursors, in addition to ozone itself, to gain a better understanding of chemical reactions producing ozone.

What is monitored in the PAMS program

Nitrogen oxides and ozone are two criteria pollutant categories monitored as part of the PAMS program. In addition, two categories of volatile organic compounds (VOCs), hydrocarbons (56 distinct compounds plus unidentified unknowns) and carbonyls (acetone, acetaldehyde, and formaldehyde) are measured. Total reactive oxides of nitrogen (NO_y) has received recent scrutiny as a factor in O_3 generation, so it, too, is included in the data set.

How are VOCs measured?

The measurement of individual VOC pollutants in ambient air has required the introduction of sophisticated laboratory instruments and techniques, such as gas and liquid chromatography, into field locations. The high sensitivity of this equipment allows the measurement of very low concentrations of VOCs.

Continued on next page

How are VOCs measured? Continued

Laboratory grade gas chromatographs (GCs) take and analyze hourly air samples at PAMS sites during the summer season months: June, July, and August. These measurements were taken at four of the seven PAMS sites currently operating in Massachusetts during the 2000 season.

The PAMS monitoring network

PAMS monitoring is required in Boston and Springfield because these areas coincide with southwesterly and northwesterly wind directions that are prevalent during high ground ozone events. PAMS monitoring stations are located upwind and downwind from these cities.

USEPA regulations, issued subsequent to the passage of the Clean Air Act Amendments, require metropolitan areas to establish a certain number of PAMS sites based upon population. As a result, Springfield is required to have three PAMS sites and Boston is required to have five. The regional scale of ground-level ozone has led to a wide distribution of sites. One "Boston Area" site is in Maine (Acadia National Park); one "Providence Area" site is in Massachusetts (Truro - Cape Cod National Seashore); and one site is shared by Boston and Providence (Easton - Borderland State Park).

Below are PAMS stations associated with or located in Massachusetts.

Boston	Springfield	Providence
Easton (Borderland State Park)	Agawam	Easton (Borderland State Park)
Lynn	Chicopee	Truro (Cape Cod NS)
Newbury (Plum Island)	Ware	
Boston (Long Island)		
Maine (Acadia National Park)		

Collection of PAMS data is very costly and the resulting data set is complex to analyze and utilize. Studies are underway to make the PAMS system and database more efficient, less costly, and user-friendly.

The different types of PAMS monitoring schedules

USEPA Clean Air Act Regulations dictate the intensity of hydrocarbon and carbonyl monitoring, depending on the site's proximity to the central city. Lynn (Boston) and Chicopee (Springfield) are designated to have the most intensive PAMS related sampling. The types of samples taken during the 2000 season are the following:

- Gas chromatographs took 1-hour hydrocarbon samples every day in June, July, and August at sites in Lynn and Newbury (eastern Massachusetts) and at sites in Chicopee and Ware (western Massachusetts).
- Eight 3-hour time weighted hydrocarbon canister samples are taken every third day during the summer at Agawam, Easton, and Truro locations.

Continued on next page

The different types of PAMS monitoring schedules, Continued

- Eight 3-hour time weighted carbonyl samples are collected at sites in Lynn and Chicopee every third day throughout the summer.
- All PAMS sites collect ozone, nitrogen oxides, and meteorological data continuously throughout the summer.

A number of PAMS target pollutants, including benzene and formaldehyde, are of concern because of their toxic properties. In addition to the monitoring schedule described above the following is in effect:

- Every sixth day, 24-hour time weighted samples (canisters and carbonyls) are taken throughout the year at the Lynn and Chicopee locations. The results from these samples contain data for some health relevant volatile organic compounds in addition to the PAMS target compounds.
- Every sixth day, 24-hour hydrocarbon canister samples are collected throughout the year at Long Island in Boston Harbor. These samples serve double duty of toxics analysis for comparison with the other toxics sampling location at Dudley Square.

Both hydrocarbon canister and carbonyl samples are at the Air Assessment Branch (AAB) headquarters in Lawrence.

Characteristics of PAMS data

Collection of PAMS data generates thousands of data points for many parameters. Air quality scientists are particularly interested in data collected during periods of high ozone episodes. Meteorology, precursor activities, and ozone production can be studied.

Typically, ground-level ozone concentrations rise during the morning and afternoon and fall as the sun sets and cuts off the reaction energy source. This is dependent on the solar intensity and the transport of ozone produced upwind. Concentrations of ozone precursors, such as nitrogen oxides and hydrocarbons emitted from vehicles, rise at the morning rush hour but decline throughout the day as they are consumed in ozone-related chemical reactions.

Analyzing the patterns of PAMS data

Air quality scientists use PAMS data to look at upwind and downwind data concentrations. They thus can estimate how much of the ozone participating compounds are locally produced versus wind transported and how those proportions affect locally measured ambient ozone concentrations.

Isoprene is a particularly interesting ozone reactive hydrocarbon because it is emitted primarily by trees during hot weather. When high temperatures occur, isoprene concentrations peak. These peaks dip as ozone rises because isoprene is consumed during ozone formation. Sampling areas that are heavily forested have high isoprene concentrations.

Continued on next page

A look at PAMS data on a high ozone day

The spatial and time relationships between PAMS compounds are studied to explore their connection with ground-level ozone production. The following are graphs of four pollutants that were measured on a high ozone day in 1998 at the three PAMS sites in the Springfield area. Agawam is the upwind site, Chicopee is the central city location (immediately downwind of Springfield), and Ware is the downwind location (where ozone values may be expected to be highest).

Ozone, toluene, nitrogen dioxide, and isoprene are plotted on each graph.

- Toluene is plotted as an example of a petroleum hydrocarbon.
- Nitrogen dioxide is plotted as the primary reactive oxide of nitrogen.
- Isoprene is plotted in contrast to toluene, as a biogenically (i.e. trees) emitted hydrocarbon.

Chicopee data are shown below. Toluene and nitrogen dioxide are pollutants associated with vehicles and are expected to be higher in a more urban setting like Chicopee than in more rural settings. Toluene values peak during rush hours when traffic is highest. Notice that ozone peaks a few hours after the hydrocarbon peaks, after the chemicals have had time to react.

Chicopee VOC, O3 and NO2 on a High Ozone Day
July 16, 1998

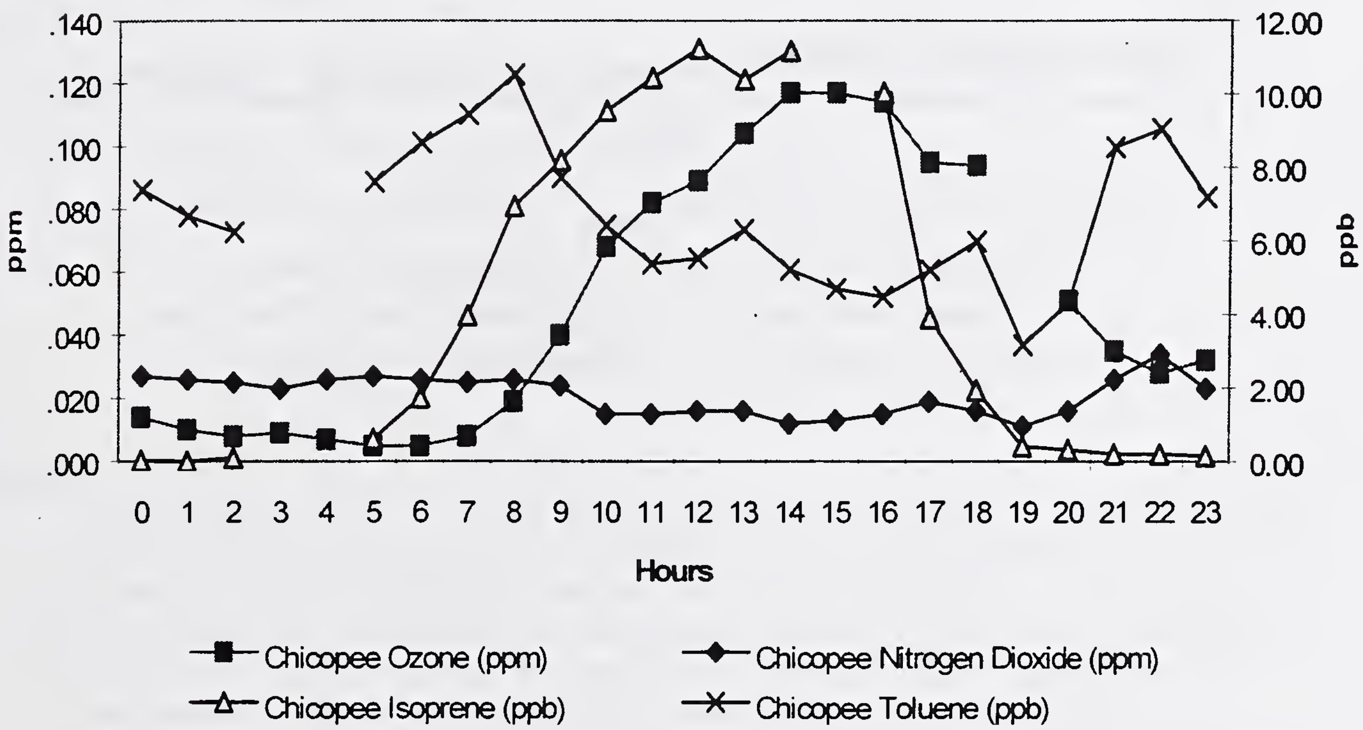

Figure 49

Continued on next page

A look at PAMS data on a high ozone day, Continued

The next figure shows the same data from Ware.

The structure of the ozone peak is more complex at this downwind site than the upwind location (Agawam) because locally produced ozone mixes with ozone transported into the region, which forms two offsetting components to the peak.

The Ware station consistently records high isoprene levels because of its location at the Quabbin Reservation, which is heavily forested. Ware is a good example of the biogenics (isoprene) curve following the diurnal temperature pattern.

Ware VOC, O3 and NO2 on a High Ozone Day
July 16, 1998

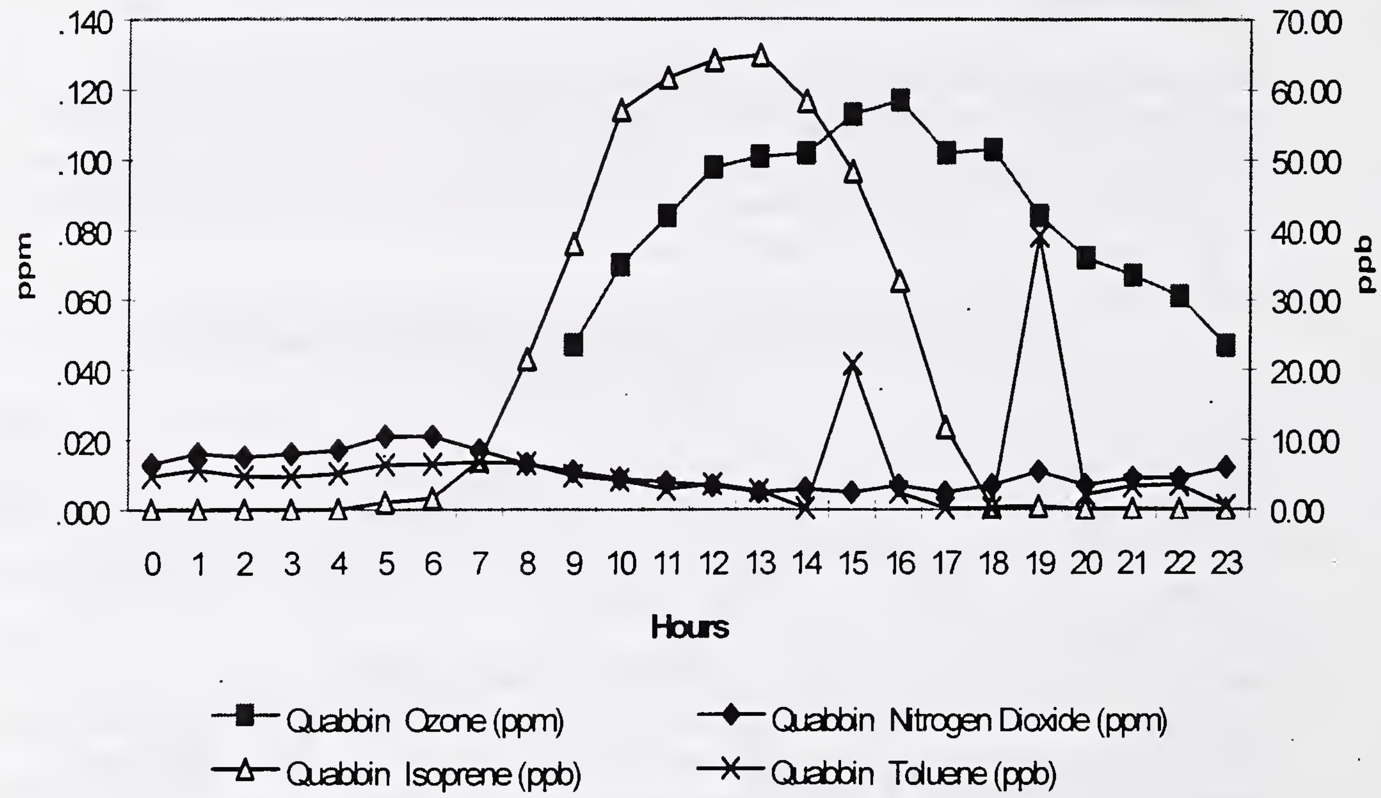

Figure 50

Continued on next page

A look at PAMS data on a high ozone day, Continued

Figure 51shows that the peaks at Agawam follow the same pattern as at Chicopee and Ware. The ozone peaks occur a few hours after the peaks in the hydrocarbons, allowing for the reaction time of the nitrogen oxides and hydrocarbons.

Agawam VOC, O3 and NO2 on a High Ozone Day
July 16, 1998

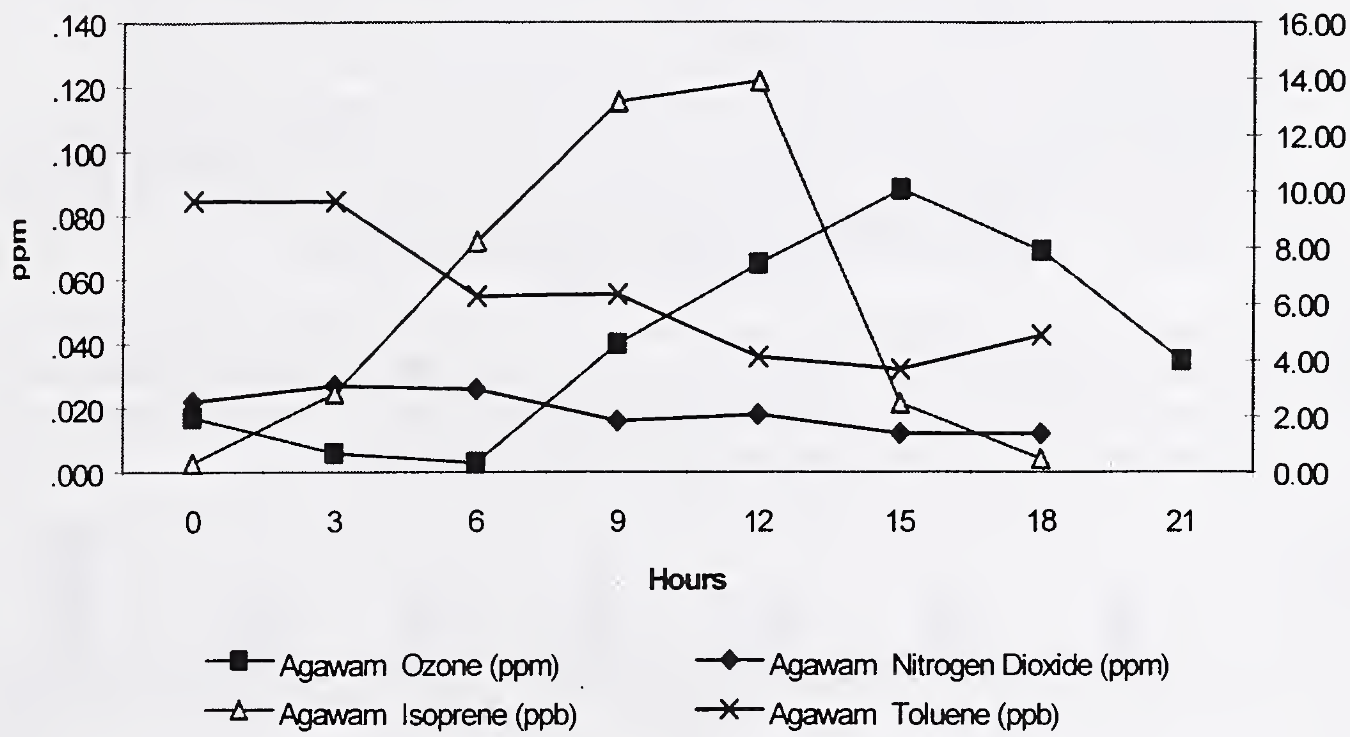

Figure 51

PAMS Future Developments

As can certainly be inferred from the prior text and data, PAMS is a complicated and resource-intensive program. As other high-priority monitoring initiatives have come forward to challenge PAMS for resources and attention, states across the country have been looking into options to refocus the program's objectives and streamline the network. In fact, states on the eastern seaboard (NESCAUM and MARAMA organizations) issued a contract for data analysis to Sonoma Technology, Incorporated to make recommendations pertaining to PAMS network modifications. In advance of this report, MADEP modified its network for the 2001 season dropping Agawam from measuring hydrocarbons and converting Ware from the hourly automated GC to the eight canisters every third day schedule. These changes were confirmed by the study, which was finalized after the 2001 season field deployment occurred.

Air Toxics Monitoring

Introduction

Toxic air pollutants usually refer to chemicals that are capable of causing long-term health effects and include volatile and semi-volatile organic compounds, toxic elements, and toxic minerals (e.g., asbestos and silica). Over the last 15 years, the Air Assessment Branch has been involved with short-term, site-specific monitoring studies for toxic air pollutants, and has reviewed and commented on plans and results from such studies that have been conducted by private contractors for MADEP.

Air toxics monitoring program

Recently, nationwide discussions have been held to revive efforts to monitor toxic air pollutants at representative ambient locations on a routine schedule. Sixth day 24-hour canister sampling began in October 1999 at the new Long Island (Boston Harbor) and Roxbury sites using the EPA PM_{10} schedule.

These weekly samples are shipped to the Rhode Island State Department of Health Laboratory for gas chromatograph-mass spectrometer (GC-MS) analysis according to USEPA Method TO-15. This analysis determines concentrations of a number of target toxic volatile organic compounds in ambient air samples.

Below is a table which shows a summary of results for 24-hour samples in 2000 of selected target VOCs for the two sites. As expected, the mean concentrations were higher for the target pollutants at the central city location (Harrison Ave.) than those at the background site on a Boston Harbor island (Long Island).

	BOSTON (Harrison Ave)		BOSTON (Long Island)	
Compound	Max Value ppb	Mean ppb	Max Value ppb	Mean ppb
1,3-butadiene	0.64	0.09	0.20	0.02
1,1,1-trichloroethane	0.15	0.05	0.08	0.05
trichloroethylene	0.07	0.01	0.06	0.01
tetrachloroethylene	0.18	0.04	0.12	0.02
benzene	1.81	0.47	0.69	0.22
toluene	10.62	1.30	1.36	0.40
xylenes	2.68	0.79	0.79	0.22
ethylbenzene	0.57	0.18	0.18	0.06

Continued on next page

Air toxics results from PAMS monitoring

As described in the above PAMS Section, MADEP collects 24-hour hydrocarbon and carbonyl samples every six days year round at the Chicopee and Lynn sites. From the hydrocarbon analyses, values for several health relevant compounds (benzene, toluene, and xylene) can be extracted from the PAMS results. Benzene is included on USEPA's urban air toxics list. Also on the list are formaldehyde and acetaldehyde which are target PAMS carbonyl compounds.

Below is a chart summarizing concentrations of 24-hour health relevant PAMS target compounds for samples taken at the Lynn PAMS site from 1994 through 2000. The benzene concentration decreased, likely the result of the use of reformulated gas beginning in 1995.

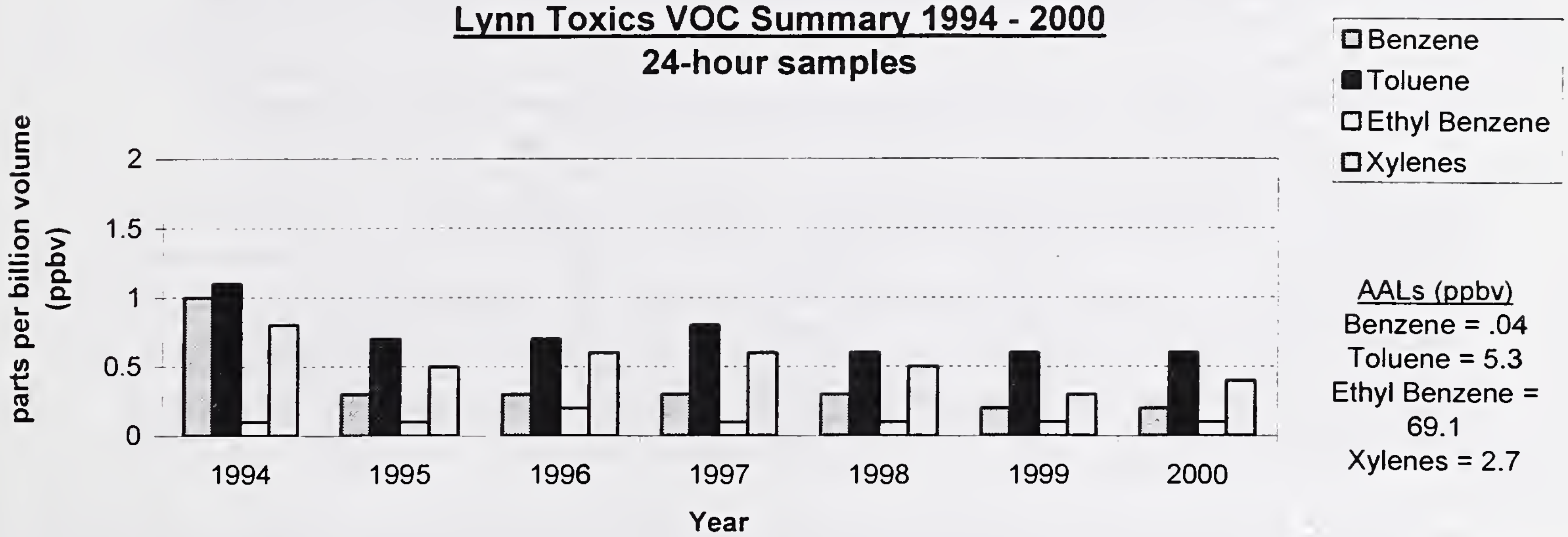

Figure 52

Allowable Ambient Limits (AALs) are health-based air toxics guidelines developed by MADEP based on potential known or suspected carcinogenic and toxic health properties of individual compounds. Safety factors are incorporated into the AALs to account for exposures from pathways other than air. AALs are reviewed and updated periodically to reflect current toxicity information.

Continued on next page

Mercury sampling

From July 1997 through June1999, an ambient mercury (Hg) sampling program was conducted at the Ware site as part of the New England Regional Ecological Monitoring and Assessment Program (REMAP) mercury study. This site was one of five participating locations in New England where 24-hour mercury vapor and particulate samples were taken every sixth day for two years. The program also included a two-year wet deposition component to determine mercury concentrations in rainwater in the New England Region. Samples from four sites were sent to the University of Michigan for analysis. The fifth site, Bridgton, ME, was operated by the NADP and is not included in the results below.

A data and quality assurance report has been published for the first year of the study, 7/97-6/98. Preliminary results are available from the second year, 7/98-6/99. Below are the precipitation concentration and deposition results from the four New England sites analyzed by University of Michigan. Concentration shows the concentration of Hg in daily event precipitation samples and deposition shows the deposition Hg in precipitation.

July 1997 – June 1998	Concentration	Deposition
Acadia, ME	6.8 ng/L	10.9 ug/m2
Underhill, VT	8.9 ng/L	12.1 ug/m2
Ware, MA	9.7 ng/L	12.5 ug/m2
Providence, RI	9.7 ng/L	14.5 ug/m2

July 1998 – June 1999	Concentration	Deposition
Acadia, ME	8.7 ng/L	10.2 ug/m2
Underhill, VT	9.1 ng/L	11.3 ug/m2
Ware, MA	9.4 ng/L	8.9 ug/m2
Providence, RI	9.9 ng/L	9.6 ug/m2

Section V

Emissions Inventory

Emissions Inventories: 1990–1999

Introduction

The emissions trends are presented for four major pollutants of concern: volatile organic compounds (VOCs), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and carbon monoxide (CO). Emissions data are not available for particulates and lead. The emissions trends cover the period from 1990 to 1999.

Reporting emission inventories

Emissions inventories are required by USEPA every three years. The basic emission methodology involves multiplying an activity factor by an emission factor. MADEP uses a wide range of activity factors such as fuel types, employment, vehicle miles traveled, and population. Emissions factors and methodology are provided by USEPA. MADEP spatially adjusts the emissions to counties and seasonally adjusts them for the summer.

Massachusetts is in non-attainment for the O_3 and CO national air quality standards and therefore has a State Implementation Plan (SIP) that describes emissions and control measures. The 1990 SIP included a base-year emissions inventory for VOCs, NO_x, and CO, from which air pollution control programs were developed.

The emissions estimates for the years 1990, 1993, and 1996 emissions were submitted to USEPA as part of the SIP process. The 1999 VOC, NO_x, CO, and SO2 emissions estimates presented here are preliminary and were derived from the incomplete 1999 Periodic Emissions Inventories (PEI).

The State Acid Rain (STAR) program

SO_2 emissions are tracked annually by MADEP as part of the requirements of the 1985 State Acid Rain (STAR) program. The STAR program was implemented to control emissions that cause acid deposition, which is harmful to the environment. The STAR program is more stringent and establishes a lower SO_2 emissions cap than the federal Acid Rain Program. The 412,000 ton state cap is based upon the average annual SO_2 emissions during the four-year base period of 1979–1982. MADEP is required to implement additional control measures if the SO_2 cap is exceeded, which has not occurred since the inception of the STAR program. The preliminary SO2 estimate for 1999 is 148,000 tons, which is less than half the cap.

Continued on next page

Point source emissions trends

The point-source category of the emissions inventory comprises the large industrial facilities and power plants. This is the only category in which actual data is available for all ten years because of USEPA annual reporting requirements. Figures 53 and 54 show that VOC, SO_2, and NO_x point-source emissions during the 1990-1999 period decreased substantially, while CO has increased slightly.
The power plant, utility SO_2 and NO_x emissions are presented in Figure 55 and decreased substantially for the period. Power plants comprise the major proportion of NO_x and SO_2 point-source emissions. Year-to-year changes in emissions reflect the adoption of emission controls as well as the weather and economic conditions.

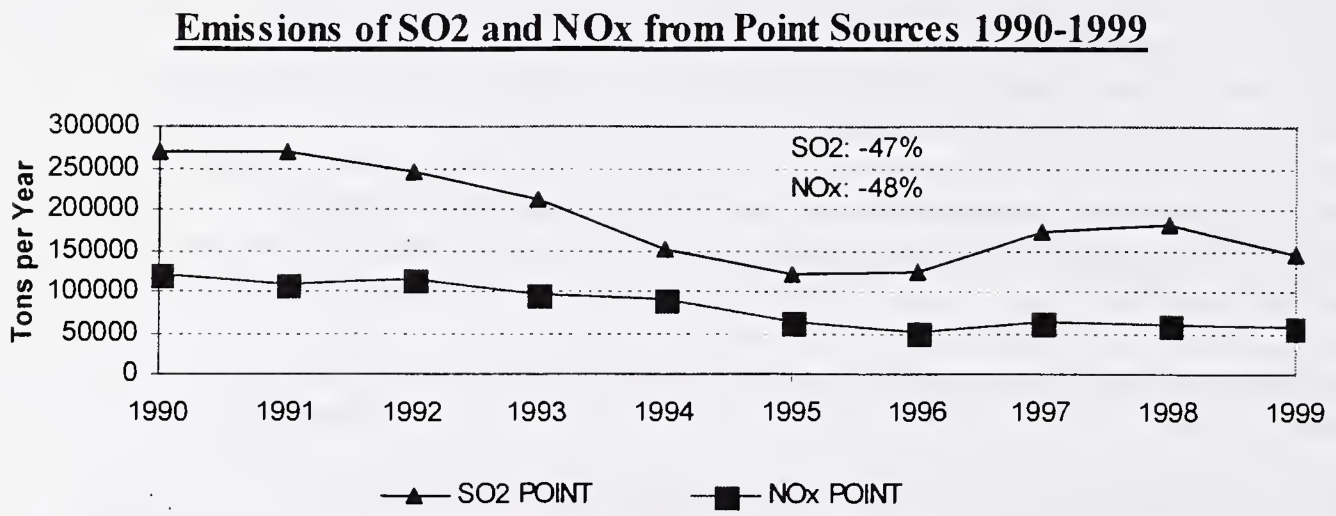

Figure 53

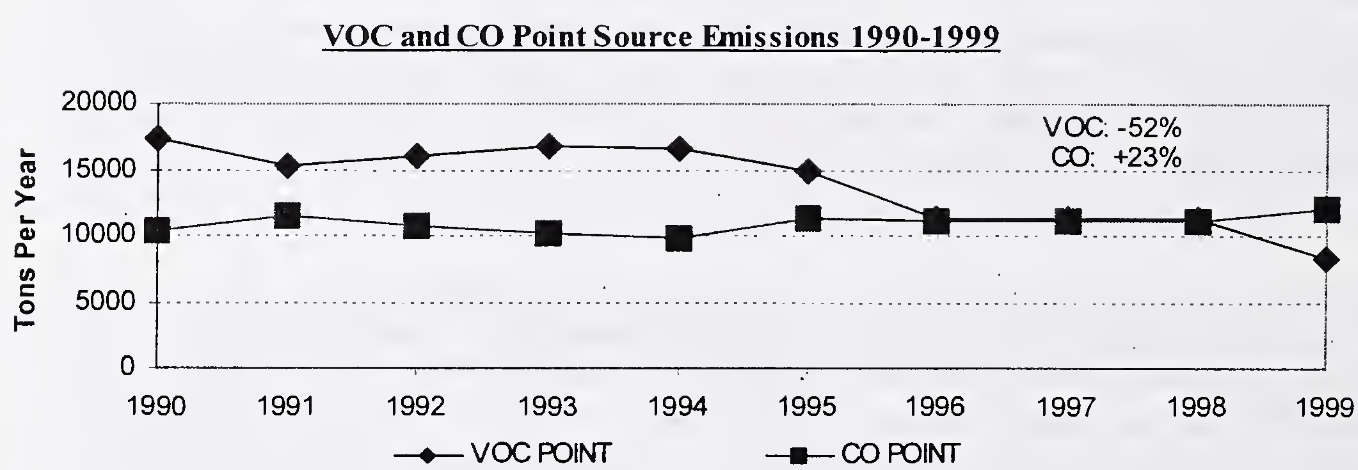

Figure 54

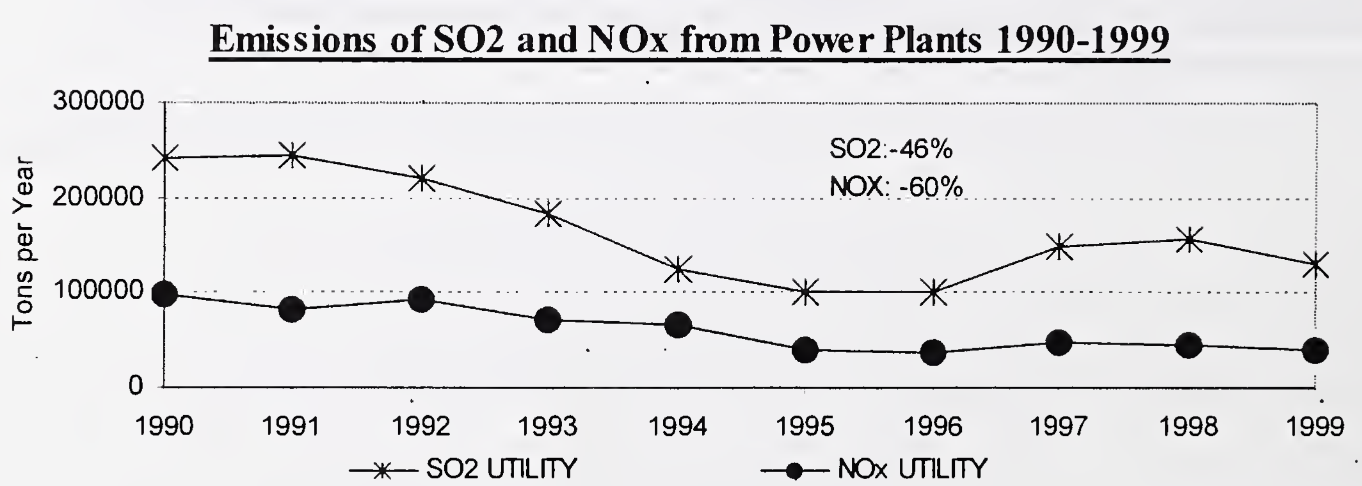

Figure 55

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VOC, NO_x, CO and SO_2 emissions sources

VOC, NO_x, CO, and SO_2 emissions are produced from the source categories described below:

- Point: a stationary source of air pollution, primarily from smokestacks in manufacturing facilities and power plants.
- Area: small point sources too numerous to measure individually, such as gas stations, dry cleaners, and consumer products. Taken in the aggregate they may release a substantial amount of emissions.
- On-Road Mobile: a category of mobile sources that includes common on-road vehicles such as autos, trucks, motorcycles, and buses.
- Off-Road Mobile: a category of mobile sources that comprises engines that are not usually operated on a road, such as construction equipment, boats, aircraft, locomotives, snowmobiles, and lawnmowers.

VOC emissions trends

Total VOC emissions were reduced by 24% during the period 1990-1999. Figure 56 (below) shows the composite VOC emissions trends for the period.

On-road mobile VOC emissions were reduced by 34% even though the vehicle miles traveled (VMT) increased 15% during the period. The on-road mobile reduction is attributed to the Federal Motor Vehicle Control Program, the California Low Emission Vehicle Program (adopted by Massachusetts in 1995), the Basic Inspection and Maintenance (I/M) Program, Stage II vapor recovery for gas stations, and reformulated (lower volatility) gasoline.

The off-road mobile VOC emissions decreased by 9% from 1990-1999.

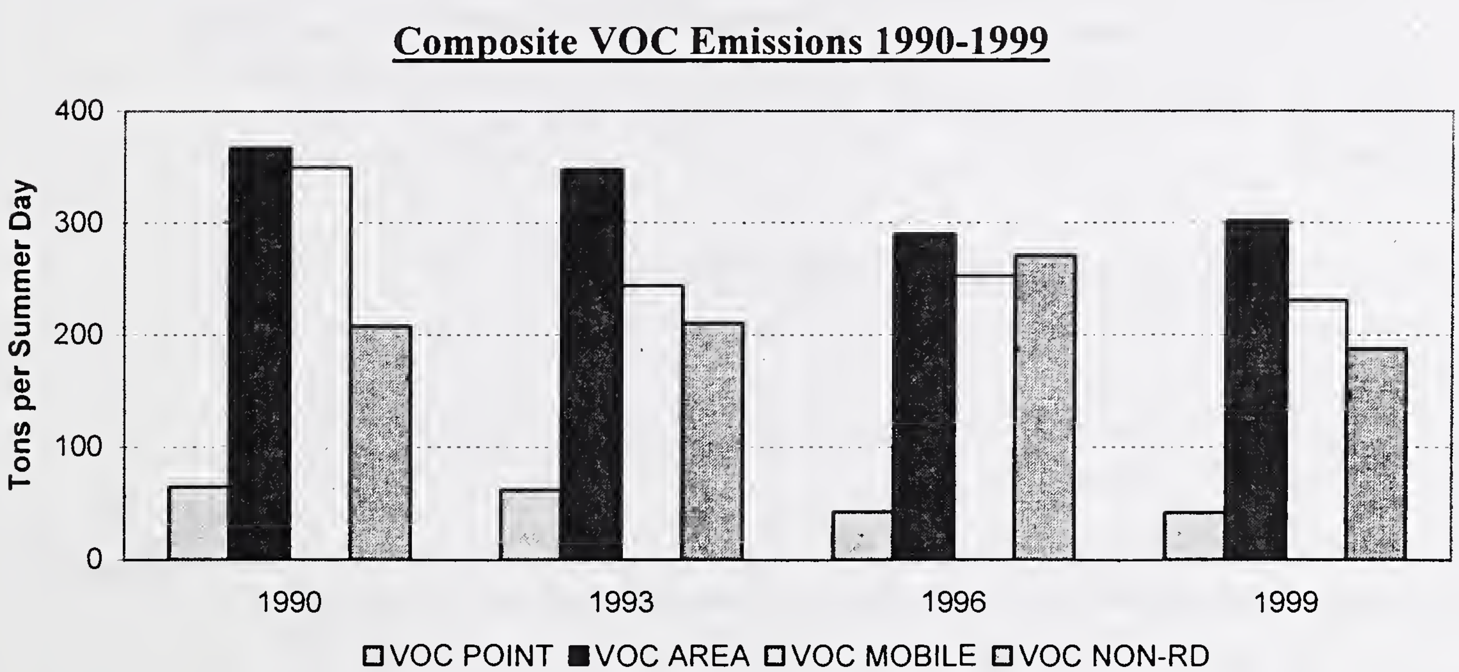

Figure 56

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NO_x emissions trends

Total NO_x emissions decreased by 6% during the period 1990-1999. Figure 57 (below) shows the composite NO_x emissions trends for the period.

Point-source emissions, primarily power plants, were reduced by 44% for this period. Area on-road and off-road mobile emissions increased by 6%, 8%, and 16% respectively. These increases are attributable to the 15% increase in VMT. Also, the 1990 to 1999 on-road mobile-source controls targeted VOC emissions and therefore had little effect on NO_x emissions. NO_x controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

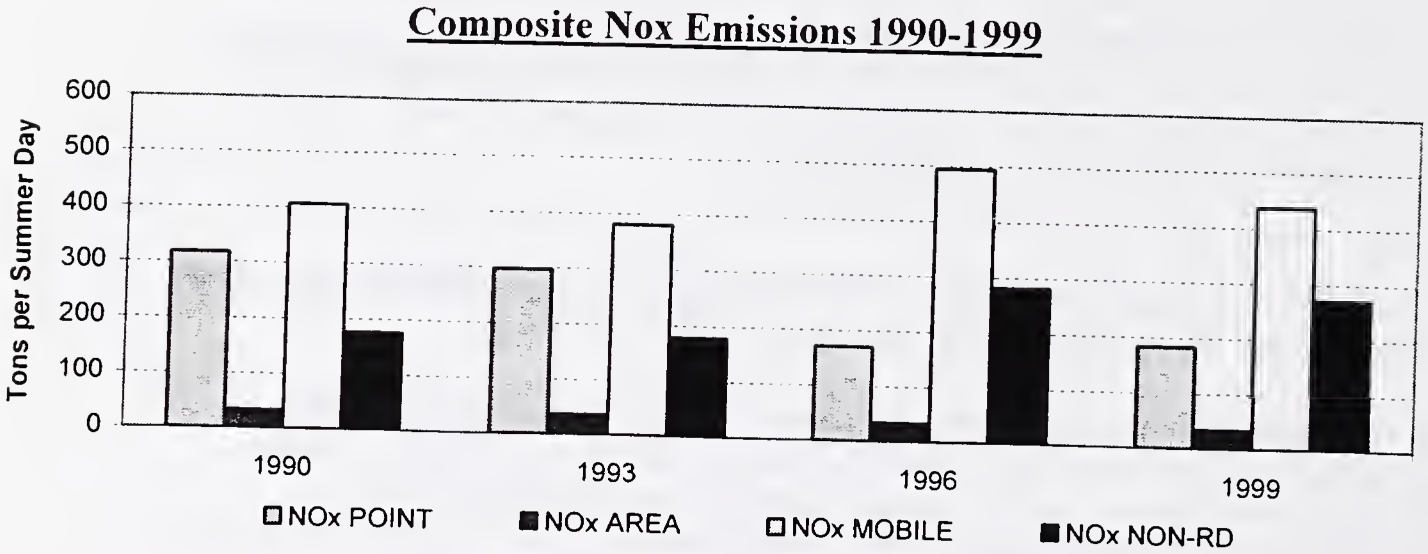

Figure 57

CO emissions trends

Total CO emissions were reduced by 21% during the period 1990-1999. Figure 58 (below) shows the composite CO emissions trends for the period.

On-road mobile emissions decreased by 43% for this period. Because on-road vehicles contribute the greatest amount of CO emissions, the decrease in emissions offsets the 24% increase in point source emissions and 13% increase in off-road emissions. Again, these increases are due to controls targeting VOC and NO_x reduction.

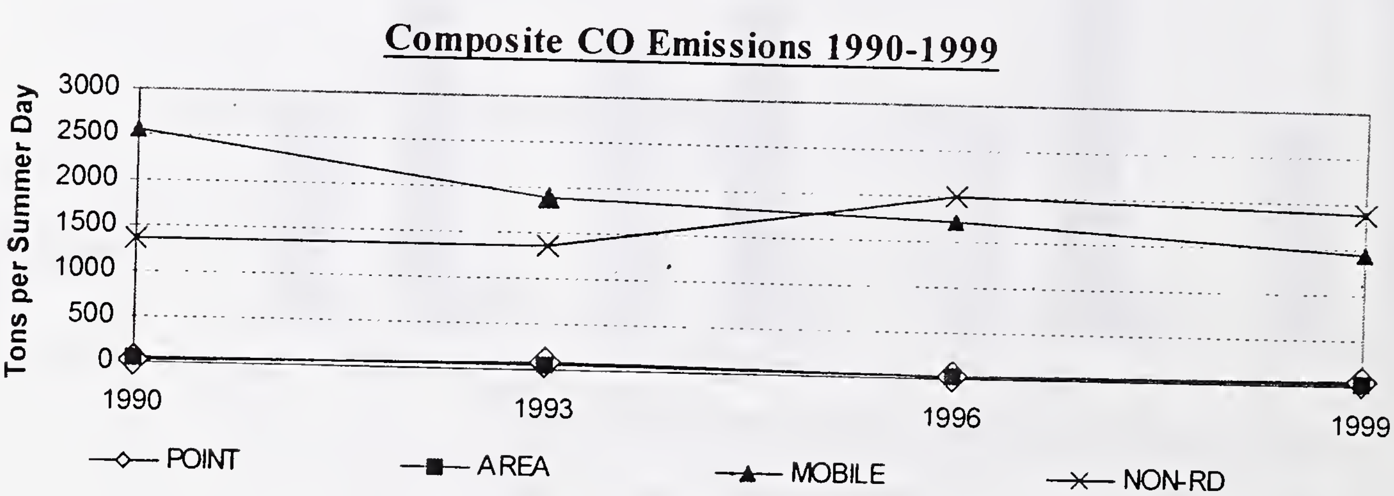

Figure 58

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Emissions Inventories: 1990-1999, continued

On-road mobile source emissions trends

Figure 59 (below) shows the 1990-1999 trends for on-road mobile VOC and NO_x emissions, together with daily vehicle miles traveled (DVMT).

The VOC on-road mobile emissions decreased by 34% despite an increase of 15% in DVMT. This is a reflection of the effective on-road mobile-source control programs that were instituted during the period.

NO_x mobile-source emissions increased by 8%, because the on-road mobile-source controls had been targeted toward VOC reduction. NO_x controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

CO mobile-source emissions decreased by 43% for this period.

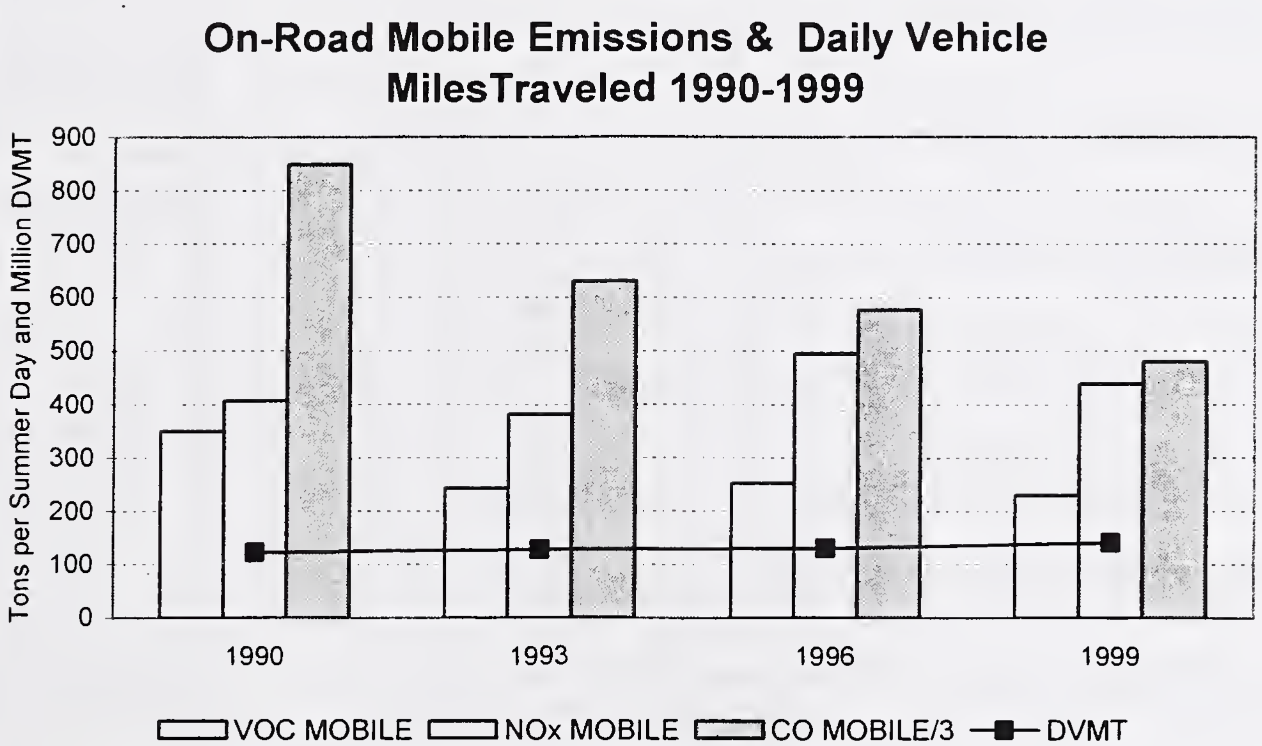

Figure 59

Appendix A: Public Site Location Coordinates

CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
ADAMS Mt. Greylock Summit	25-003-4002	18	UTM(East)650160 (North)4721890 LAT +42:38:12 LONG -73:10:07
AGAWAM 152 Westfield St.	25-013-0003	18	UTM(East)692120 (North)4659040 LAT +42:03:42 LONG -72:40:41
AMHERST N. Pleasant St.	25-015-0103	18	UTM(East)703800 (North)4696975 LAT +42:24:01 LONG -72:31:25
BOSTON Kenmore Square 590 Commonwealth Ave.	25-025-0002	19	UTM(East)327095 (North)4690373 LAT +42:20:54 LONG -71:05:57
BOSTON Fire Headquarters Southampton St.	25-025-0012	19	UTM(East)329584 (North)4688213 LAT +42:19:46 LONG -71:04:06
BOSTON 340 Bremen St. East Boston	25-025-0021	19	UTM(East)333008 (North)4693531 LAT +42:22:41 LONG -71:01:42
BOSTON Fire Station 200 Columbus Ave.	25-025-0024	19	UTM(East)329406 (North)4690316 LAT +42:20:55 LONG -71:04:16
BOSTON 1 City Square Charlestown	25-025-0027	19	UTM(East)330090 (North)4693015 LAT +42:22:22 LONG -71:03:49
BOSTON Post Office Square	25-025-0038	19	UTM(East)330840 (North)4691500 LAT +42:21:34 LONG -71:03:15
BOSTON Long Island Hospital Road	25-025-0041	19	UTM(East)337656 (North)4686725 LAT +42:19:03 LONG -70:58:12
BOSTON 1129 Harrison Ave. Roxbury	25-025-0042	19	UTM(East)328394 (North)4688242 LAT +42:19:46 LONG -71:04:58
BOSTON 174 North Street North End	25-025-0043	19	UTM(East)330841 (North)4691917 LAT +42:21:46 LONG -71:03:15
BROCKTON 120 Commercial St	25-023-0004	19	UTM(East)333300 (North)4660379 LAT +42:04:47 LONG -71:00:55
CHICOPEE Westover Air Force Base	25-013-0008	18	UTM(East)701792 (North)4674012 LAT +42:11:39 LONG -72:33:22
EASTON Borderland State Park	25-005-1005	19	UTM(East)322200 (North)4658820 LAT +42:03:47 LONG -71:08:56
FAIRHAVEN Wood School Scontuit Rd.	25-005-1002	19	UTM(East)343300 (North)4610800 LAT +41:38:07 LONG -70:52:53

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CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
FALL RIVER Fire Headquarters 165 Bedford St.	25-003-3001	19	UTM(East)320961 (North)4618523 LAT +41:42:01 LONG -71:09:06
FALL RIVER Fire Station Globe St.	25-005-1004	19	UTM(East)319694 (North)4616888 LAT +41:41:07 LONG -71:09:59
FITCHBURG Fitchburg State College 67 Rindge St.	25-027-2004	19	UTM(East)271158 (North)4719399 LAT +42:35:42 LONG -71:47:21
HAVERHILL Consentino School Washington St.	25-009-5005	19	UTM(East)327700 (North)4736400 LAT +42:45:46 LONG -71:06:21
LAWRENCE Wall Experiment Station 37 Shattuck St.	25-009-6001	19	UTM(East)322599 (North)4729400 LAT +42:41:55 LONG -71:09:57
LAWRENCE Storrow Park High St.	25-009-0005	19	UTM(East)324221 (North)4730569 LAT +42:42:34 LONG -71:08:47
LOWELL Old City Hall Merrimack St.	25-017-0007	19	UTM(East)310489 (North)4723770 LAT +42:38:42 LONG -71:18:42
LOWELL High School 50 French St.	25-017-0008	19	UTM(East)310474 (North)4724048 LAT +42:38:51 LONG -71:18:43
LYNN Lynn Water Treatment Plant 390 Parkland St.	25-009-2006	19	UTM(East)337855 (North)4704157 LAT +42:28:28 LONG -70:58:21
NEW BEDFORD YMCA 25 Water St.	25-005-2004	19	UTM(East)339500 (North)4610110 LAT +41:37:43 LONG -70:55:36
NEWBURY US Department of the Interior Sunset Boulevard	25-009-4004	19	UTM(East)352040 (North)4738800 LAT +42:47:22 LONG -70:48:33
PITTSFIELD Silvio Conte Federal Building 78 Center St.	25-003-5001	18	UTM(East)643496 (North)4701187 LAT +42:27:06 LONG –73:15:18
QUINCY Fire Station Hancock St.	25-021-0007	19	UTM(East)332391 (North)4682065 LAT +42:16:29 LONG -71:01:57
SPRINGFIELD Howard School 59 Howard Street	25-013-0011	18	UTM(East)699454 (North)4663358 LAT +42:05:56 LONG -72:35:17
SPRINGFIELD Liberty St.	25-013-0016	18	UTM(East)699140 (North)4664480 LAT +42:06:32 LONG -72:35:29

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Appendix A: Public Site Location Coordinates, Continued

CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
SPRINGFIELD 1586 Columbus Ave.	25-013-2007	18	UTM(East)699150 (North)4663534 LAT +42:06:02 LONG -72:35:30
STOW U.S. Military Reservation	25-017-1102	19	UTM(East)295450 (North)4698475 LAT +42:24:49 LONG –71:29:09
TRURO Cape Cod National Park Fox Bottom Area	25-001-0002	19	UTM(East)415100 (North)4647381 LAT +41:58:33 LONG -70:01:29
WALTHAM U. Mass Field Station Beaver St.	25-017-4003	19	UTM(East)317750 (North)4694520 LAT +42:23:01 LONG -71:12:50
WARE Quabbin Summit	25-015-4002	18	UTM(East)719712 (North)4686127 LAT +42:17:54 LONG -72:20:05
WORCESTER Worcester Airport	25-027-0015	19	UTM(East)262797 (North)4684016 LAT +42:11:27 LONG -71:52:34
WORCESTER YWCA 2 Washington St.	25-027-0016	19	UTM(East)269108 (North)4682163 LAT +42:15:33 LONG -71:47:57
WORCESTER Fire Station Central St.	25-027-0020	19	UTM(East)269152 (North)4683021 LAT +42:16:02 LONG -71:47:56
WORCESTER Grafton and Franklin Sts.	25-027-0022	19	UTM(East)269599 (North)4682294 LAT +42:15:39 LONG -71:47:36

Appendix B: Industrial Site Location Coordinates

REPORTING ORGANIZATION CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
ATLANTIC GELATIN Stoneham (Hill St.) Hill Street	25-017-1701	19	UTM(East)326462 (North)4704385 LAT +42:28:28 LONG -71:06:40
SITHE NEW ENGLAND Boston Long Island	25-025-0019	19	UTM(East)337595 (North)4686595 LAT +42:19:00 LONG -70:58:15
SITHE NEW ENGLAND Dorchester Dewar Street	25-025-0020	19	UTM(East)330548 (North)4685952 LAT +42:18:34 LONG -71:03:22
SITHE NEW ENGLAND East Boston Bremen Street	25-025-0021	19	UTM(East)333008 (North)4693531 LAT +42:22:41 LONG -71:01:42
SITHE NEW ENGLAND South Boston East First Street	25-025-0040	19	UTM(East)331871 (North)4690009 LAT +42:20:46 LONG -71:02:28
HAVERHILL PAPERBOARD Haverhill Nettle School	25-009-5004	19	UTM(East)331385 (North)4737365 LAT +42:46:20 LONG -71:03:40